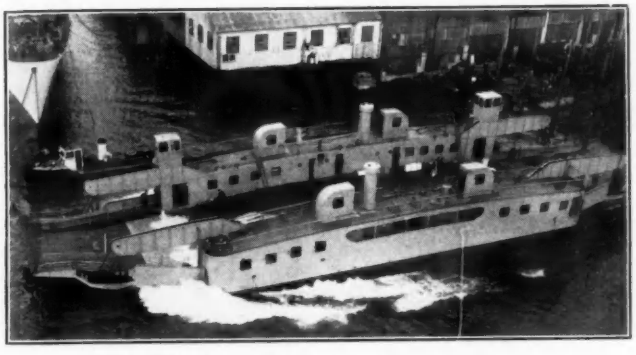
Three Thornycroft Contracts

A new launch for the Medway Conservancy Board has recently been completed at the Hampton yard of John I. Thornycroft & Co. Ltd. The launch, of round bilge form, is 57 ft. in length, with a beam of 13½ ft. and a draft of approximately 3 ft. 9 in. It will be used for patrol, survey and general duties arising from the greatly increased traffic in to and out of the river. The wheelhouse, which has been designed to give a clear headroom of 6½ ft., has all-round visibility and is arranged with the steering wheel on the centre line and the instrument panel in front of the helmsman's position, engine controls adjacent. The main machinery comprises two turbo-charged mirror handed diesel engines, each fitted with oil operated reverse gears incorporating 2 : 1 reducing gears, developing 160/200 s.h.p. The designed speed is 16 knots.



One of the new diesel-electric chain ferries.

Two diesel electric chain ferries are being constructed for the Cornwall County Council, for whom Messrs. Graham and Woolnough, Liverpool, are acting as consultants. The ferries are to replace the existing steam ferries at Torpoint and will normally operate a 15 minute service between Torpoint and Devonpoint. They have a length O.A. of 182 ft., a breadth of hull of 54 ft. and a mean loaded draft of 5 ft. 9 in. and will move at a speed of 630 ft. per minute. They are expected to be completed shortly.

The Belfast Pilotage Authority has ordered a pilot vessel, 54 ft. in length O.A., with beam of 14 ft., and draught of about 5 ft. The propelling machinery will be a Rolls-Royce type C6 diesel engine with a maximum rating of 300 b.h.p. at 2,000 r.p.m., and fitted with reverse and reduction gear. The vessel is expected to have a speed of about 12 knots.

Radio-telephone System in Bombay Harbour

The first v.h.f. radio-telephone service in India for communication between a ship and the shore has just been inaugurated in Bombay Harbour.

Pye 20-Watt F.M. Ranger duplex equipments have been installed on the training ship 'Dufferin', which is permanently anchored in the harbour and at the Nautical and Engineering College on shore. This latter station is in turn connected to local PABX and through it to the Bombay public telephone system. In addition, a mobile radio-telephone set the P.T.C. F.M. 8702 which can be taken on board a launch or pilot vessel will provide direct communication with the 'Dufferin'.

The installation of radio-telephones at the port has fulfilled a long-felt need. Hitherto the only communication with shore was by means of signalling lamps—both slow and unsatisfactory—and men of the 'Dufferin' had to make a 15-minute trip by launch to the shore to make telephone calls.

Messrs. Forbes Forbes Campbell & Co. Pvt. Ltd., distributors in India for Pye Telecommunications Limited of Cambridge, England, were responsible for installing the system.

Improved Safety Sling

Cable Covers Limited, the manufacturers of the widely used "Talurit" Wire Rope Mechanical Splice, have now introduced an improved "Talurit" Safety Sling which can be supplied in any length and width, any lifting capacity and with a wide variety of terminations amongst which are shackles, reeving links, soft eyes, crescent thimbles and enlarged thimble eyes. These terminations or a combination of any two can be fitted at either end of the Sling.

The improved Sling incorporates the well known "Talurit" Wire Rope Mechanical Splice and the construction is such that complete and thorough periodic inspection of all slings can be undertaken in a matter of minutes without the employment of any special tools or gear.

The Sling gives complete protection to personnel and offers the ideal solution to the handling of products which are fragile, valuable or irregular in shape. In fact, it has specially been designed and made to fill every demand when the instruction, "Handle With Care", means what it says. Full information may be had from Cable Covers Limited, St. Stephen's House, London.

Crane and Excavator Contracts

Thomas Smith & Sons (Rodley) Ltd., the crane and excavator makers, have received an order from the Admiralty for eight diesel shunting cranes. Four of these are to be of 5-tons capacity, two of 6-tons and two of 10-tons. In addition, the Admiralty has ordered two 10-ton diesel-electric shunting cranes. All these machines are for delivery during 1961 and it is understood that they are to be employed at Admiralty establishments in the West Country.

Following an order for twenty Smith '21' excavators which were supplied to the Spanish government some time ago for hire to contractors, Chesney & Webb who are the company's agents in Madrid have taken delivery of seven other machines for various customers and are now awaiting delivery of three ¾-cu. yd. capacity Smith '21's' for Gineo Navarro e Hijos Constructiones S.A., who are amongst the largest contracting firms in the country.

Five ¼ to ¾ cu. yd. Smith '21' excavators were shipped to New Zealand this month bringing the total number of Smith excavators in service there to 165. The Company have a number of other orders in hand for New Zealand including five crawler cranes, fitted with 44 in. magnets, which are to be employed on scrap handling duties at a new steel works and five more excavators.

Comprehensive Range of Marine Radar

At a meeting held at the Festival Hall in London early this month, at which some 500 shipping representatives were present, Decca Radar Ltd. introduced a new series of marine radar which increases their former range of 7 sets to a total of 12 sets. This now consists of eleven 3 cm. (X-band) radars and one 10 cm. S-band) radar.

Incorporated into the series is a modification which is expected to reduce the risk of collisions in waters of high traffic density. Known as interscan, this technique is a method by which accurate information can be obtained rapidly on true or relative motion display. The interscan is a continuously visible electronic line which appears on the P.P.I. originating from own ship's position. By the variation in length and direction of this line, range and bearing information can be obtained quickly and accurately.

The four new 3 cm. radars all employ 75-kw. transceivers and a high performance, 10-ft. slotted waveguide aerial system. The four sets are: the D535, Relative Motion with 9-in. display unit, the D838, Relative Motion with 12-in. display unit, the TM939 True Motion with 12-in. display unit and the TM969, True Motion with entirely new 16-in. display unit.

It is claimed that the TM969 with the new aerial, represents the most advanced 3 cm. marine radar yet available, possessing features which can make an important contribution towards safety at sea.

Another new feature of the 16-in. display is a polaroid daylight viewing hood (Deccavue) permitting simultaneous viewing by two operators in normal direct lighting. This set also includes built-in True Motion, seven range scales extending from ¾ to 60 nautical miles, variable differentiation giving control of picture sharpness to suit physical characteristics of the locality and the grouping of controls according to their function so that they come readily to hand when required.

The 10 cm. True Motion set is the first British radar to be built for operation on a wavelength previously used exclusively by American equipment. Employing a 13-ft. slotted waveguide aerial, a 75-kw. transceiver and the same 16-in. True Motion display console as the TM969 3 cm. radar, this set is designed for use either as a single installation or in conjunction with a 3 cm. radar from the D.11 series when the advantage of a choice of frequency is required in order to minimise the effects of interference and to enable the most suitable frequency to be employed under any given geographical or weather conditions.

This set incorporates 20 r.p.m. aerial rotation, giving a good data rate necessary for efficient display; integral True Motion on the master display; range and bearing measurements by interscan; choice of two true motion and three relative motion presentations; peak power of 75-kw.; range scales and markers to maximum range of 60 miles; the new "Deccavue" daylight viewing hood, and the provision of variable differentiation.

The full range of 12 radars provides shipowners with an exceptionally wide choice to meet every requirement and, it is claimed, offers sets possessing higher performance and more advanced features than are available with any comparable equipment.

New Contracts for Grain Handling Plant

Simon Handling Engineers Ltd. announce that they have been awarded two contracts for the supply of grain handling equipment. Four travelling pneumatic ship-discharging plants, each with a capacity of 200 tons an hour and complete with quay conveyor installation, will be supplied to the Port of Bristol Authority. The value of the contract exceeds £500,000 and is part of the modernisation scheme now in hand at the port to increase the turnround of shipping.

To assist efficient discharge of the larger grain ships using the King George Dock at the Port of Hull, the British Transport Commission has ordered a further floating pneumatic grain elevator with a capacity of 300 tons an hour. The new machine, which will cost approximately £270,000, will be an addition to two similar elevators at present working at the Dock.

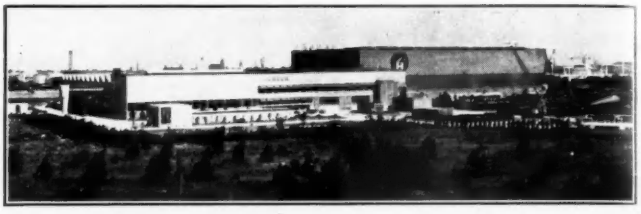
New Works of N. V. Machinefabreik Hensen

The new factory built for the well known Dutch engineering firm of N.V. Machinefabreik Hensen at Eemhaven, Rotterdam was officially opened in September last.

This firm, established in 1875, have gained an international reputation as makers of cranes and other mechanical handling appliances, including mobile cargo unloading plants for bulk materials—iron ore, coal, bauxite, sugar, grain, etc.—with capacities of 1200-1500 tons/hour. They specialise in the construction of cranes of all types and sizes and now rank among the largest crane-building firms on the Continent. Most of the leading Dutch and Belgian shipyards are equipped with Hensen cranes, and the Port of Rotterdam alone has over a hundred quay cranes supplied by this firm, who have also executed orders for equipment for the Netherlands Railways, the Netherlands Navy, and the State Mines.

The new factory site covers a total area of 92,000m², including 20,000m² of buildings. The latter comprise a main engineering shop, a fabrication shop, subsidiary workshops of various kinds, a drawing office, a canteen, stores, offices, washing facilities, etc. The main engineering shop and the fabrication shop are each 115 m long by 40 m wide.

The site, which is situated on a major navigable waterway, is provided with a quay 180m long and 14m wide, affording berthing



The new factory at Eemhaven, Rotterdam.

accommodation for sea-going vessels. In view of the firms considerable volume of exports to foreign countries, including Britain, Ireland, Belgium, Sweden, Brazil, etc., the possession of deep-water berthing facilities immediately adjacent to their works is a very considerable advantage.

As a large proportion of the firm's activities are concentrated on exports, they maintain a team of skilled erection and service engineers who are prepared to go to any country in the world in the course of their duties.

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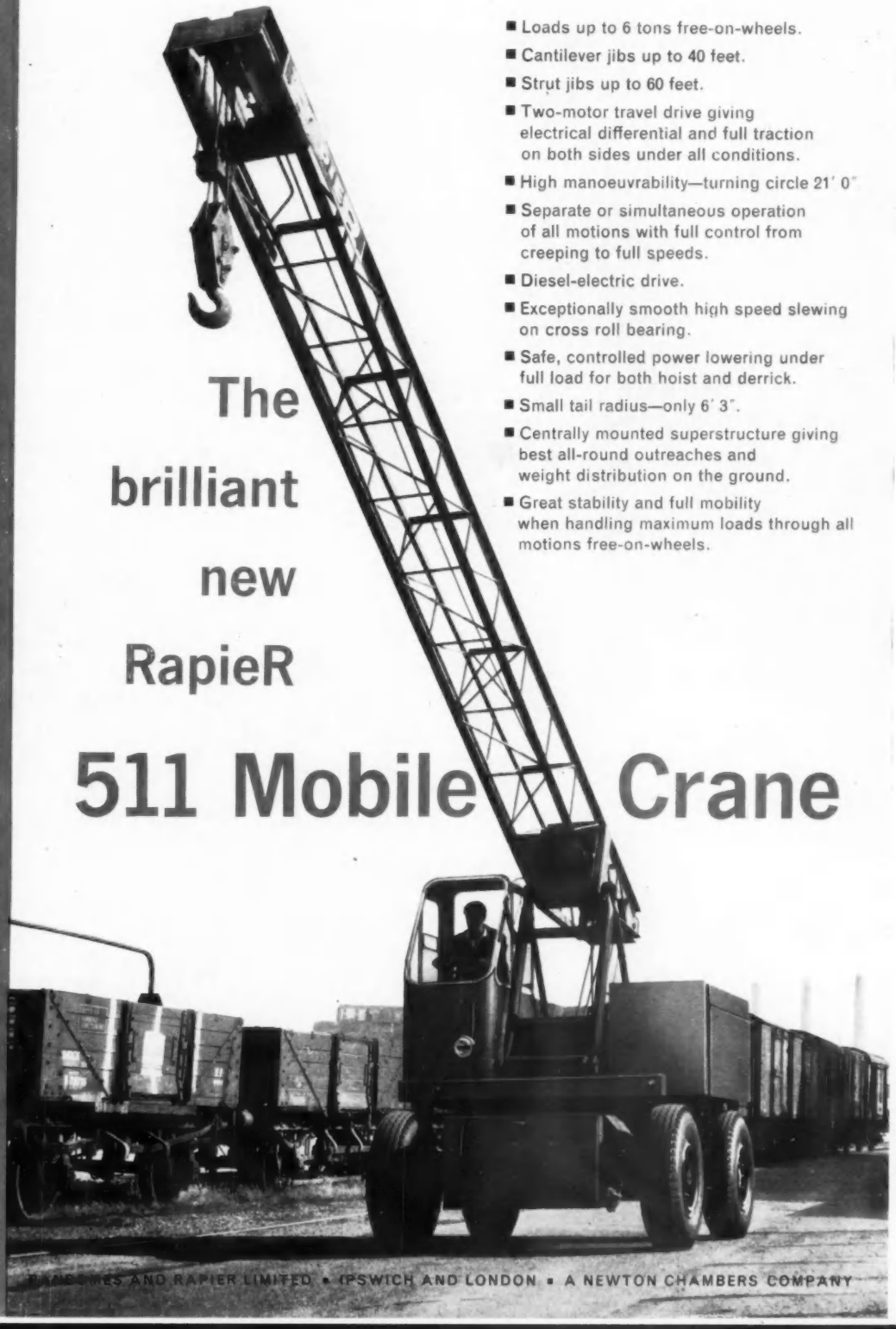

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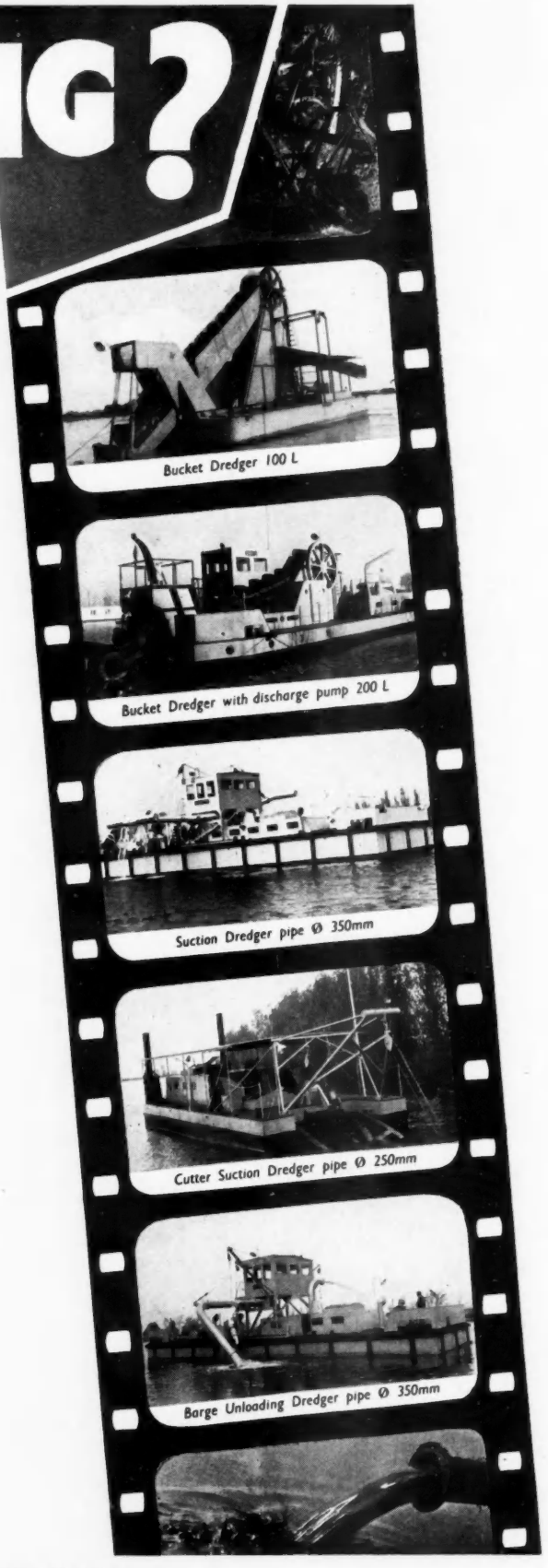

Bucket Dredger 100 L

Bucket Dredger with discharge pump 200 L

Suction Dredger pipe Ø 350mm

Cutter Suction Dredger pipe Ø 250mm

Barge Unloading Dredger pipe Ø 350mm

AGENTS THROUGHOUT THE WORLD

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Editorial Notes

Oil Terminals at Milford Haven

The economics of size are perhaps more readily distinguishable with tankers than with any other type of vessel, for liquid cargoes (provided they remain liquid) do not incur added complication with increasing volume. This is more particularly so with homogeneous cargoes, however, so it is for the long haul to major refining centres that the so-called super-tankers find their profitable employment, generally on a long term charter basis, leaving the wider distribution of refined products to vessels of more modest dimensions. The super-tankers owe their genesis as a class to the initiative of National Bulk Carriers Inc. and vessels in this category first came into service late in 1956; with a laden draught of 46-ft. and over and a beam of 125-ft. (compared with the 118-ft. of *Queen Elizabeth*), they posed problems of accommodation and maintenance which confined their use to a few selected routes. The first vessel on her maiden voyage in fact, had to be partly discharged into T2 tankers alongside before she could be moved in to her intended berthing point. In the succeeding four years much has been done in developing and modernising terminal arrangements at the principal centres to meet the changing circumstances. The largest tanker now in service has a carrying capacity of 105,000 DWT, and it would seem that this represents something like the practical limit of size for her leading dimensions have become the yardstick for designing the newest shore installations.

Hitherto tankers larger than 65,000 DWT have not been seen in British waters although not long ago the British Petroleum Company constructed a terminal at Finnart, Loch Long, which is capable of berthing the largest vessels and delivering their contents by pipeline to the Grangemouth refinery on the Firth of Forth. Now, with the inauguration of two additional deep-water terminals at Milford Haven, visits by such vessels to our shores can confidently be expected although it may be some time before they can be considered as regular callers.

The article which we print in this issue describes the facilities provided by the operating division of B.P. Ltd. on the south side of the Haven at Angle Bay, which are linked by pipeline to the company's refinery at Llandarcy, some 60 miles away. The other oil terminal at Milford Haven is that of the Esso Petroleum Co., serving their newly constructed refinery closely adjoining. Here the traffic is two-way, for the jetties provide also for the outward loading of refined products into general purpose tankers. The B.P. venture was conceived before any statutory conservancy authority had been appointed for the Haven as a whole although it was clearly recognised that growing industrialisation would necessitate some regulatory body, not only to protect foreshores and maintain safe navigation for deep-draught vessels, but to concert with other planning authorities means of preserving public amenity as far as possible. The B.P. site was, in fact, acquired in 1956 although the Milford Haven Conservancy Board was not established until two years later.

Both oil terminals, Esso and B.P. provide for the simultaneous berthing of two tankers of about 100,000 DWT. Long approach jetties are needed at both sites to obtain sufficient depth of water for such vessels at any state of the tide, with suitable foundation conditions for the substantial structures required; that at Angle Bay is some 1300-ft. long but the Esso terminal entails approaches almost three times as long. In both cases effective use is made of precast units for the deck members. Here the similarity ends, however, for structurally the two projects have been conceived on quite different lines.

The Esso work employs hollow prestressed piles throughout the substructure, having external diameters of 22-in. and 27½-in. Some of these piles are as much as 140-ft. long and were driven by exceptionally heavy single-acting hammers from raking frames equipped with pendulum leaders which were mounted upon an LST adapted to serve as a pontoon. The B.P. work at Angle Bay obtained its stability to resist berthing impact by means of mass concrete "strong points", two of these, joined by a precast concrete deck on steel box pile supports, comprising each berth. These strong points were built within sheet piled cofferdams excavated down to bedrock and each contains 15,000 tons of concrete, which gives some idea of the magnitude of the forces encountered. The supporting structure for connecting and approach jetties and mooring dolphins consists of steel box piles all of which are electrically bonded for cathodic protection by the impressed voltage system using different types of anode in different places. Only the dolphin piles are so protected at the outset, the remainder relying for the present on external coating of the exposed surfaces. Some interesting information on corrosion effects, under more or less controlled conditions, should be revealed by this arrangement.

Goods Handling between Ship and Shore

The paper read before the Institute of Transport in London which we are privileged to print in this issue takes the form of a general survey of modern trends in sea transport. Such a survey cannot delve deeply into particular aspects of the subject. Its importance lies perhaps more in its suggestiveness than in its absolute content, interesting though that can be. Does the development of shipping services and ship design lie in specialisation or in versatility? To what extent can those conflicting aims be combined in one vessel—and what then would be the scope of its employment? Such questions compose the theme of the paper under discussion.

Shipping falls broadly into two categories—the bulk carrier and the general cargo vessel. Tankers and ore carriers in the first division set remarkable standards of quick despatch. The ultimate, one must suppose, is attained by the Great Lakes ore vessels capable of loading a cargo in twenty minutes or so, and

discharging it in 3½ hours. But such vessels are doomed to spend half of their voyaging time in ballast (which must of course be reflected in freight), besides which ordinary broken stowage in a dry cargo ship would seem to be of small account. Whether combined oil/ore vessels such as *Sinclair Petrolore* have materially overcome the disability is not known. The Boy Scout's combination knife fork and spoon has never really taken on. The modern cargo liner, however, endeavours to carry full cargoes outward and homeward and its success in this is measured by the ability of its agents to assess the potentialities of commerce along the route and to identify themselves with the merchant interests which they serve. Although these vessels are designed to suit the circumstances of traffic on their voyage itineraries, this is a broad requirement which does not generally restrict their value to that route alone except that, once established, there is every incentive to nourish the goodwill which has slowly been built up. For port contacts should never come to be regarded as unfortunate interruptions in a sequence of perpetual plain sailing.

The theoretical attractions of container working (as the term is usually understood) are obvious. Here should be a way of speeding turn-round and reducing demurrage or detention of a ship sufficient to permit a lowering of freight levels. Innovations of this kind tend to cut across the fabric of commercial usage, however, and consequently their introduction is slow. The employment of containers has made more progress, therefore, in military traffic where commercial considerations are of lesser moment. Containers should not of course be looked on as a means of transferring the cost of stowing and unstowing in detail —always a laborious process—to other pockets, for it is essential that operations should be costed as a whole, not arbitarily in part. The implications run deep. We can all picture a container but we can only define it by saying that it is a box to put other people's containers in. Where a shipper can use whole containers little difficulty arises, but, as there are good reasons for dimensioning containers up to the limit of road and rail transport, practical problems of handling remain. It is where the container wears a common-user aspect that the difficulties multiply. Ocean freight is compounded of the greater of weight or measurement and what the traffic in a particular commodity will bear. The consignor ordinarily pays directly for his own voids and indirectly, it must be supposed, for the average cargo voids. The carrier must know what goods are being shipped, apart from important questions of the hazardous nature or inherent vice of cargo. Accordingly, it would appear that the carrier must himself (or through his agents) supervise the stowage of the goods in the container rather than rely on the declaration of a third party. Thus the relationship between carrier and cargo owner would remain unaltered, and though the carrier would need in practice to provide the container, the merchandise and not the container could continue to be the basis of the contract of carriage. Nevertheless, worthwhile advantages might flow from such a policy despite the fact that the problems of stowage remain and are merely concentrated—and perhaps accentuated—in another place.

Any large scale growth of container traffic will pose problems to the naval architect which he can be counted on to resolve. Ingenious solutions using stern ports, rolling decks and linked derricks have already been proposed by Capt. V. C. Farrell, to mention only one fruitful innovator. As for port installations, aprons, and cranes (where they exist), will mostly be inadequate. Much more emphasis will be placed on open space. In the examples described in the paper a full cargo of containers (assumed to be weatherproof) will occupy before dispersal something like 2½ acres of ground. The better access and elbow room required might possibly be obtained by orientating the fashionable wide sheds at right angles to the quayside in the layout of new marginal wharves if here, too, versatility is the objective.

New Passenger Terminal at Southampton

We published in October a description of the new passenger facilities at Sydney primarily designed to accommodate the new liners *Oriana* and *Canberra* shortly to enter the Australia, New Zealand and trans-Pacific services being developed by the P & O–Orient Lines partnership. The importance of this new shipping venture has been marked again by the provision by the British Transport Commission of modern passenger accommodation at Southampton on which port these magnificent vessels will be based. The P & O group has previously made sporadic use of Southampton for its passenger liner services although its main terminal has been at Tilbury, but the advent of the larger ships and the superior amenity and convenience of Southampton have now brought about a major change of policy. The new facilities have just been officially opened by Field-Marshal Viscount Slim who has only recently completed his term of office as Governor General of Australia; as a former deputy-chairman of the Railway Executive of the Transport Commission, Lord Slim, will have felt a double sense of satisfaction at being associated in this way with such an attractive project. The occasion was well timed to coincide with the departure of *Oriana* on her maiden voyage. We hope to print a description of the new terminal accommodation in a later issue of this Journal.

The significance of the new round-the-world route lies in the fact that it offers a more diversified service in most modernly appointed ships designed, not only for one particular service, but also with complete flexibility of use on any other route, including the North Atlantic. Working in a wider ambit and with the means of adjusting accommodation to differing requirements enables seasonal fluctuations in travel demand on individual route stages to be offset, somewhat in the manner pioneered by the Shaw Savill eastabout and westabout round-the-world service. Clearly, vessels employed in this way can undertake little or no cargo commitment and must be designed to make minimum demands on port facilities.

Both *Oriana* and *Canberra* carry substantially as many passengers as either of the *Queens* of the North Atlantic, and at very nearly the same service speed. The combined investment in them is much the same as the replacement cost of the *Queen Mary*. But whereas the proposal to finance 60 per cent of that cost from public funds has aroused acute controversy in British shipping circles traditionally opposed to subsidies in any form, the P & O venture is being provided for entirely out of taxed profits aided, of course, by the usual 40 per cent investment allowance. Resourcefulness and initiative of this order, in the face of strenuous competition from subsidised air travel, deserves the highest commendation.

Tally Clerks in the Port of London

The committee of inquiry into the recent "unofficial," and highly damaging, strike of tally clerks in the Port of London has found positively nothing to be said in the clerks' favour. The London Dock Labour Board is also criticised for tending to do too little too late; it should not allow itself to be deterred by threats from performing its statutory duty of maintaining an adequate and unbalanced register of dock workers. Specific recommendations of the Committee (which the Board are now considering) are that a separate sub-register of "Docker-checkers" should be instituted, as is the practice in other ports, who would do the work of tally clerks when none of the latter were available; that the clerks should no longer be hired on a weekly basis except when an employer is willing to guarantee a minimum of six months' continuous employment. This should put an end to the selfish retention of tally clerks during weeks when extra business is likely, a feature of the situation preceding the strike which enabled the clerks still further to exploit their scarcity value.

B.P. Terminal at Milford Haven

Deep Water Berths at Angle Bay

(Specially Contributed)

THE ever increasing size of modern oil tankers has created a problem of berthing accommodation for the oil companies which they have only been able to solve by the construction of new deep water terminals, of which a number are being and have been built in many places in the world. These terminals are designed specially to berth ships which require more space and greater depth of water than almost any other class of vessel afloat.

The BP Refinery at Llandarcy in South Wales has for many years depended for its supply of crude oil on tankers berthing at Swansea. Passage through the entrance lock at Swansea is limited to ships of less than about 28,000 tons, this handicap has led the Company to consider the development of an alternative port capable of handling the huge new vessels now coming into use.

In 1956 BP Trading Ltd. purchased an area of land at Angle Bay on the south side of Milford Haven about 60 miles from Llandarcy for the construction of a new deep water terminal for tankers.

Milford Haven

Milford Haven is a natural inlet running from west to east inside the extreme south western tip of Wales. It is some nine miles long and from ½ to 1½ miles wide with a depth of water at low tide exceeding fifty feet. Development of Milford Haven as a port has been slow, due mainly to the poor landward communications. There is a naval dockyard at Pembroke Dock and until recently the smooth waters of the Haven were used for a RAF sea plane base.

The overall cost of the BP Angle Bay Project is about £6½ million and it comprises two deep water tanker berths at Popton Point, administrative offices at Popton, a tank farm for storage of the crude oil at Kilpaison Farm a mile or two away and a 60 mile pipeline to Llandarcy with one main pumping station beside the tanks at Kilpaison.

Whilst it is not, of course, possible to construct a terminal of this size without affecting local conditions BP Trading Ltd. have taken a great deal of trouble to harmonise the new works with their surroundings. The south side of Milford Haven is part of the Pembrokeshire Coast National Park, a section of the Act of Parliament giving approval to the construction of the works stipulates consultation between the oil companies, the National Parks Commission and local planning authorities. On Popton Point, at the landward end of the jetty approach stands an old fort, built in 1863 but which had been disused for many years and was in a very dilapidated condition. BP decided to restore and adapt it as the administrative offices for the terminal; they also carried out extensive excavation within the old magazine area to accommodate fuel tanks providing 30,000 tons of ships bunkers, the level of these tanks being sufficiently low for them to be screened from sight by the walls of the fort. Public access to the shore of Angle Bay is not interrupted and continuity of the Pembroke coastal footpath is maintained.

Pipeline To Llandarcy

The pipeline to Llandarcy, which is the longest crude oil pipeline in the British Isles, has a capacity of five million tons of crude oil a year, two million tons more than the refinery's present output. The single 18-in. diameter steel pipe is buried underground throughout its entire length, leaving the land, with topsoil carefully replaced, free for agricultural use.

During construction there were many natural and artificial obstacles in the path of the pipeline, including the crossing of 12 major and nearly 100 minor roads, a canal, three underground aqueducts and several main gas lines. Presenting the greatest difficulty were the rivers, thirty-seven of which, both large and small, had to be crossed. The river Towy, the most formidable barrier, measures about 500-ft. in width at low tide and nearly

The shorearm and No. 1 berth under construction. In the background are the old fort, the oil tanks and the contractor's working area.

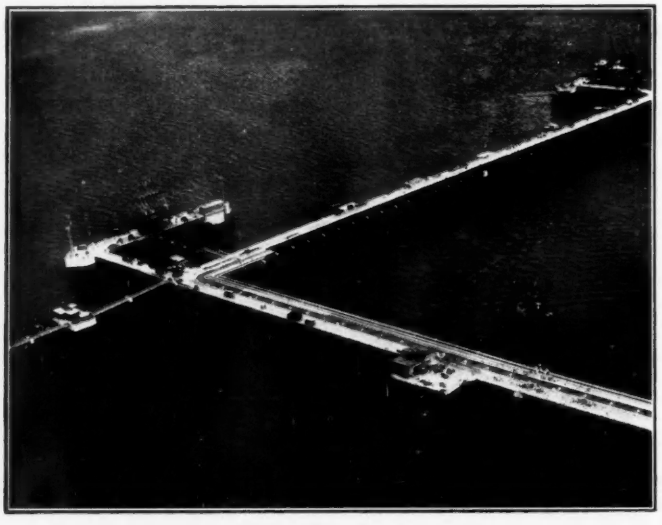
1,500-ft. at high tide and this crossing was complicated by the main London to Milford Haven railway line which runs along one bank of the river and effectively blocks access from that side. A trench was dug across the bed of the river with a floating dragline and the pipe was floated out and sunk into position. A concrete culvert continued the run of the pipe under the railway line. As the work proceeded all joints were tested under an air pressure of 100 lb/sq. in. and after completion the whole line was tested hydraulically to a pressure of 1,200 lb/sq. in. Radiographic inspection of the welding was employed and about 2,500 welds were checked by this method.

The Jetties

The basic conditions for the design of the jetties themselves, as laid down by BP Trading Ltd. called for two berths, either one capable of accommodating a 100,000-ton d.w.t. tanker in 54-ft. of water at low tide. The Consulting Engineers arranged for detailed surveys to be made of the Haven in the regions of Angle Bay and Popton Point. A hydrographic survey was carried out to determine depths, current speeds and directions; all available wind records for the area were examined, a geological report on the strata of the sea bed of the Haven was prepared and a large number of bore holes and probings were made. In addition before the type of structure to be erected was decided test piles were driven and subjected to loading, deflection and extraction tests.

The actual siting of the jetties was decided between the conflicting needs for, on the one hand, a minimum length of approach arm from the shore and a minimum depth of bedrock to ensure economy of structural cost and, on the other hand,

a depth of water such that little dredging was required. Site conditions were complicated by the presence of a major geological fault in the area which contained a quantity of shattered rock in a clay matrix not considered suitable for heavy foundations. After many alternative layouts had been studied the jetties were sited about 1,300-ft. from the shore where the bedrock varied in depth from about 55 to 65-ft. below low water level. The layer of silt to be removed by dredging was relatively



No. 1 berth almost completed and the stores handling jetty. The buildings on the mooring dolphins are temporary huts used by the contractors.

shallow and the depth of foundation to bedrock was thus kept to a minimum.

The bed of the Haven in this region is made up of a thin layer of mud and silt overlying heavily shattered sandstone and siltstone. This formation made the design of the jetties a difficult problem, since it was considered doubtful whether piles, which would receive no appreciable support from the silt layer, would penetrate sufficiently into the rock to make the construction of a piled jetty a practicable proposition.

Gravity Structure

Thus a gravity structure came to be considered, that is a jetty standing on the bedrock and resisting overturning from wind, waves and the impact of vessels by virtue of its own weight. A jetty of this type can be made in the form of a shell, or caisson, floated out into position and sunk, later to be filled solid with sand, gravel or concrete. Alternatively the gravity piers can be constructed in-situ within a cofferdam and this last alternative was finally chosen as the most economical and as the method of construction least likely to suffer from the effects of weather and wind during the course of the work. Test piles driven into the rock showed however that for the lighter loading conditions of the approach roadways and the mooring dolphins, structures founded on piles would be economical and efficient.

Each of the two tanker berths consists of two mass concrete strong points joined by a precast concrete deck 150-ft. long supported on steel box piles. The strong points are designed on the gravity principle described above and are built within lozenge shaped steel sheet piled cofferdams measuring about 74-ft. by 38-ft. The mud, silt and loose rock inside the cofferdams was removed by grabbing and each was filled up from bedrock to deck level, a height of nearly 100-ft., with some 15,000 tons of solid mass concrete. This weight of concrete is well able to resist the forces caused by the berthing of even the largest tanker under the worst forseeable conditions.

About 200-ft. back from the berthing line is a row of eleven mooring dolphins, immediately behind which is a roadway 16-ft. wide and a pipe track 26-ft. wide, connected to the two berths by separate road and pipe necks. From the end of this roadway, or trunkway, a similar road and pipeway 1,100-ft. long runs to the shore. Halfway down this shore arm is a small stores jetty measuring about 70-ft. by 40-ft. built as a reinforced concrete slab deck on vertical and raking steel piles. At this point a 7-ton crane loads the stores into lighters which are used for final transport to the tanker, thus eliminating the fire hazard which would be caused by lorries coming onto the main jetties. Also on the stores handling jetty is a pumphouse containing two electrically driven vertical spindle submersible pumps for the main fire services and saltwater services generally.

Oil Pipes and Services

Crude oil leaves the tanker through the flexible hoses of a flow-boom hose handling installation on each berthing head. Four 10-in. hoses lead through steel booms into a single 26-in. diameter manifold on the hose deck, from where the manifold is continued as a 26-in. welded steep pipe back to the trunkway; here the pipes from the two berths run side by side to the tank farm on shore. Other pipes include 16-in. and 12-in. bunker fuel and diesel oil lines, 12-in. and 8-in. firewater and foam lines and an 8-in. portable water line. It is important that a jetty sited on the beautiful waters of Milford Haven should not be the source of oil pollution of the sea. The section of the deck under the hoses therefore is drained independently to a "slops tank" which also receives the rainwater falling on the area which may be contaminated by oil spillage. The mixture of oil and water is pumped back into the crude oil line for eventual separation at the refinery.

Fire fighting is by salt water and foam, the foam and water monitors are set on towers, two on each berthing head and these

The floating concreting plant Thor finishing work on No. 2 berth. Two of the group of four fender weights in the foreground are drawn back to the limit of their travel.

are supplemented by further monitors on the hose gantry and a large number of fire hydrants.

Shore Arm and Trunkway

The construction of the shore arm and trunkway is interesting in that wide use has been made of precast concrete units. The quality of concrete in units made under almost factory conditions on shore can be closely controlled and the thickness

and density of the concrete cover to the reinforcement can be accurately maintained. Road and pipetrack run side by side over pile bents at 27-ft. 6-in. centres. The shorearm, which carries a heavier load of pipes, has three Rendhex—4 hexagonal steel box piles per bent while the trunkway bents each have two Rendhex—6 piles. Pile lengths average about 90-ft. with a maximum of about 110-ft. Each pile is capped by a spun concrete muff about 4-ft. deep which carry and position the main transverse beams. On top of the beams run the 16-in. thick concrete road slabs, four sections 27-ft. 6-in. long making up the 17-ft. 6-in. wide slab. Joints between precast concrete units are always a problem and in this instance wide use has been made of Macalloy high tensile steel bars. The joints between adjacent

No. 1 berth and the shorearm overlooked by the storage tanks in the old fort.

road slabs are post-tensioned both longitudinally and transversely and this has the effect of making the road slab into a long beam. Stiffening against sway and wind is provided by raker piles at every fifth bent and the roadslab itself spreads the wind load between these anchor bents. Longitudinal strength along the run of the shorearm and trunkway is provided by a pair of continuous tie beams with post-tensioned joints. These beams resist the stresses from expansion and contraction in the pipes due to temperature changes. Heavy concrete anchor blocks on raker piles in each direction are placed at the centres of the shorearm and trunkway and the pipes are anchored to these.

Corrosion Protection

Provision has been made for all piles to be bonded electrically for the application of cathodic protection but only the mooring dolphin berthing head piles are so protected from the outset. Magnesium anodes on the sea bed provide this protection electrolytically. As an experiment one mooring dolphin is protected by zinc anodes welded by cast in steel lugs to the piles; these will have several times the life of magnesium at greater initial cost. Provision is made for electricity from an outside source to be applied to the shorearm and trunkway system if and when the amount of corrosion as shown by removable test pieces is sufficiently great to justify it. All piles are coated with Wailes Dove hot applied coal tar enamel, reinforced with glass fibre cloth at certain critical points; the underwater lengths of the shorearm and trunkway piles were sandblasted to remove mill scale and have been left bare.

Gravity Fenders

The design of the jetty strong points is based upon the impact force which they will have to withstand. At Angle Bay gravity fenders have been provided consisting of 100-ton weights hanging in groups of four on the face of the jetties. Each weight hangs on two pairs of links arranged so that when it makes contact with the side of the vessel it is pushed backwards and upwards into a recess in the face of the jetty. The fenders at Angle Bay have been fully described in a previous article in this journal.

Construction Work

Construction of the shore arm and trunkway proceeded concurrently with work on the berthing heads. Starting from the shore abutment the piles of the shorearm were driven from a moving gantry which, as the work continued, travelled out over piles already driven. On the platform a 10-ton steam derrick carried a 6-ton single acting steam pile driving hammer working in short hanging leaders. The derrick was also used for setting section of prefabricated steel bracing between the piles already driven. This travelling unit moved forward at an average rate of about 2 pile bents per week, picking up its piles from barges towed out from the pile coating yard at Pembroke Dock.

Behind the pile driving traveller moved a secondary gantry from which the steel box piles were filled with concrete and the muffs and transverse beams were placed. Further units in the train placed tie beams and road slabs, the final operation consisted of packing the joints with very dry mortar and post-tensioning almost immediately.

The operation of seating the road slabs on the transverse beams was facilitated by the use of soft plastic tubes, about 1-in. in diameter and filled with cement grout, which were placed in preformed recesses along the beams to form the seatings. The slabs were lowered on to the plastic 'sausages' and held in position until the grout set.

All the precasting with the exception of the centrifugally cast pile muffs was done in the contractors yard adjacent to Popton Fort. Two ten ton electric gantries over the casting beds were used to lift the units, weighing up to 15 tons each, on to rubber tyred bogies for towing the 600 yards down to the job. The mixing plant consisted of a 1/3 cubic yard pan type mixer, automatic batcher, cement silos for bulk cement and a monorail leading to the casting beds. The yard was well organised for the work and at no time were there delays due to shortage of of concrete units.

More difficult problems were encountered in the construction of the berthing heads than were met in the work on the shore arm and trunkway which generally went quite smoothly, although the long steel piles required considerable temporary bracing before the concrete units could be placed and it was mainly this temporary bracing that regulated the progress of the work.

The Strongpoints

The crux of the whole job lies in the berthing head strong points, which have to transmit the massive thrusts from the 100,000-ton vessels down to bedrock 80-ft. below.

Four similar points are called for in the design, each one of solid mass concrete poured inside a steel sheet piled cofferdam

74-ft. by 37-ft., the piles remaining to form a permanent casing. The cofferdams were filled to the −15 level with underwater concrete by means of bottom opening skips; from this level upwards the cofferdams were dewatered and the concrete placed in the dry.

The framing and bracings for each cofferdam were assembled as one unit on shore, floated out on buoyancy tanks and pinned in position with temporary piles. Larssen 4B sheet piling was driven to make up the enclosed cofferdam, mud, silt and loose rock were grabbed out and the rock bottom cleaned up and prepared for concreting by divers using air lift pumps. Underwater concrete contained 25% extra cement to allow for possible loss while placing, and after each pour any surface laitance was removed whilst still soft by the divers.

The contractor mounted two ½ yard mixers and an automatic weigh batcher on the hose platform piles between cofferdams 1 and 2 and an electrically operated gantry over the strong point under construction lowered the skips into the cofferdam. This fixed concreting plant was supplemented by the floating plant *Ugly Duckling* and the combined output was a lift of 500 cubic yards in a little under 24 hours of continuous working. Unfortunately the contractor received a set back in October 1959 when the *Ugly Duckling* capsized and sunk in a severe gale resulting in a total loss. In order to speed up the work the contractor had previously ordered a second floating concreting plant *Thor* and this now had to mix the 16,000 cubic yards of concrete for cofferdams 3 and 4 whilst the fixed plant from cofferdams 1 and 2 was re-erected on shore to supply the 4,000 cubic yards needed for the mooring dolphins.

Berth No. 1 was completed in August 1960 and the first tanker to berth was a 16,000-ton vessel laden with bunker fuel. The first large crude oil tanker of 42,000 tons arrived at the end of the month. The Consulting Engineers for the civil engineering design and construction of the jetties were Rendel, Palmer and Tritton and the main contractor Christiani and Nielsen Ltd. Constructors John Brown Ltd. were contractors for the electrical and mechanical work and Weldall and Assembly Ltd., Stourbridge, sub-contractors for the gravity fenders.

The Handling of Freight Traffic between Ship and Shore*

By S. A. FINNIS, E.R.D., M.Inst.T.
(Chief Docks Manager, Southampton, British Transport Commission)

Port facilities have come in for a good deal of criticism in this country since the second World War, and in the immediate post-war years the effects of war damage and changes in the nature of the trade of these islands took heavy toll of ships' time. So serious was the position that in 1947 the Government set up a "Working Party on the turn-round of Shipping in the United Kingdom Ports" comprised of men eminent in the fields of shipping, ports and dock labour. In their report in 1948, following visits to the ports, the Committee made many recommendations and much has been done towards implementing these. Later there was a "Working Party on Increased Mechanisation in the United Kingdom Ports" which reported in 1950, and in 1952 a "Ports Efficiency Committee" was set up. This latter Committee made two reports in 1952 and a third in 1956 and is still in being to maintain a continuing watch on the position. With the help and encouragement of these bodies the port authorities and their shipowner friends have been able to bring about a marked improvement in the general position, although seasonal and local difficulties do, of course, still occur in varying measure and are magnified from time to time by labour problems. Nevertheless, while the earlier reports emphasised the replacement of war damaged facilities and other physical assets, the attention of the operators has recently been directed more to the handling of cargo from the point of view of speeding up operations and reducing costs.

Cargo handling operations have a direct bearing on the time a vessel spends in port and since a ship is only earning revenue when she is on passage, extra time in port is an added expense to the shipowner or charterer for which there is no corresponding return. The rising costs of ships—both as regards initial and operating expenditure—have made it increasingly important that the time spent in port should be at a minimum, and while the maintenance of the ship and its servicing requires some idle time, the day-to-day supply and maintenance can generally be carried out during the discharge and/or loading of the cargo so that the ruling factor in turn-round in port becomes in most cases the time taken for these operations.

The dock or port authority also have a vital interest in the turn-round of a ship in that, by and large, the quicker the ship is finished and away, the quicker is the berth clear and ready for use by a further vessel. Generally there are only a limited number of deep-water berths available so that every additional day which can be saved is of importance. This statement needs qualification, however, for the shore berth is generally occupied for a period either in assembling traffic for export or in effecting deliveries of imported traffic. From the ship's point of view the length of time it is in port is the important factor, whereas the port operator is fortunate to benefit unless the whole operation of cargo assembly or clearance can be completed in a shorter time so that not only the wet berth at which the ship lies is ready for use again but also the adjacent shed.

The Problems of Port Operation

In simple terms the operations which take place at a dock or port are:

(a) the arrival and departure of ships;
(b) the transfer of goods and passengers between ship and shore; and
(c) the conveyance of goods and passengers between the quayside and inland destinations.

Clearly these are over simplifications and the problems of port operation become more apparent when one takes into account the size and multiplicity of cargoes, the varied size and construction of ships and the different kinds of port accommodation and facilities in existence. Above all is the necessity for co-ordinating the various activities, for ship and quay working consists of a series of operations and the limiting factor in the rate of work of the whole ship is the speed of the slowest operation. A great deal of study has in recent years been made of these operations and much too has been done by shipowners, but since there are today some 350 separate management units conducting the operations of the British fleet of merchant ships and over 1,600 registered employers of labour on the quays, it is obvious that there is the opportunity for many differing views as to what should and should not be done.

A measure of the traffic to be handled can be gauged from the fact that in 1959 United Kingdom imports amounted to some 112 million metric tons while exports, including nearly 5 million tons of coal, totalled 30 millions. These figures include the importa-

*Paper read before the Institute of Transport in London on November 4th last and reproduced by kind permission.

tion of about half our food and four-fifths of our raw materials as well as the movement of practically the whole of our exports. The most remarkable change from pre-war days is the decline in coal exports from nearly 40 million tons to 5 millions, and the fact that exports other than coal, coke and patent fuel have increased in tonnage from about 10½ million to 25 million—almost by two and a half times. Imports (by weight) have also risen by nearly 70 per cent since 1938, but here one must take account of the substitution of oil for home produced coal.

Handling of Bulk Cargoes

From the point of view of handling there is a convenient division between bulk cargoes and general cargo. Bulk cargoes are generally carried in quantity in chartered ships and include many of the raw materals which we import, and there is no doubt that since World War II great strides have been made in dealing with them. Petroleum products are an outstanding example and 3,000 tons an hour can be pumped ashore from a modern tanker. The discharge of a cargo of 33,000 tons in under nine hours, and an average rate of well above 2,000 tons per hour, make a very favourable comparison with an average of 700 tons per hour pre-war. Provided a ready berth can be found for the tanker and there is storage capacity available on shore, there can be little complaint regarding the turn-round of tankers.

Although oil has to some extent superseded coal, there is still a considerable coasting trade in coal in quantities sufficient to justify specialised berths and facilities. The most up-to-date loading berth for coal in this country is probably that which has recently been completed at Immingham in Lincolnshire, where two radial conveyors have been erected each designed to deal with 55 wagons per hour. The first shipment of 17,500 tons of washed small coal was loaded in 29½ hours at an average rate of 600 tons per hour, which is an exceptionally high rate for this class of coal and one which it would not have been possible to achieve by the older methods of hoists or hoppered staiths. With coal that runs freely and wagons of 21 tons capacity it should be possible to work at speeds in excess of 1,000 tons per hour.

Grain too, is another bulk traffic imported in quantity and now handled almost entirely by pneumatic means. Individual appliances have capacities ranging up to 300 tons per hour and with several in operation on one ship high rates can be achieved provided barge or shore capacity is available to receive it. Ores of various kinds constitute another important stream of traffic, and in this country the usual method is to use grabs in conjunction with heavy cranes or transporters. With iron ore an average rate of discharge of over 3,500 tons per day is now achieved in the United Kingdom as compared with from 500 to 700 tons in pre-war days.

In considering the handling of these types of traffic three important points should be noted. Firstly, that a high proportion of specialised and purpose-built ships are in use. Tankers are an obvious example, ore carriers are increasing in numbers, and in the coastal coal trade a large number of colliers have been specially built. Secondly, specialised and purpose-built machinery is generally in use for loading and/or discharge, and the berths are normally reserved for these traffics. Thirdly, in the case of most bulk traffics between regular ports adequate provision has been made for the handling of the traffic ashore. These are all of importance in making any comparison with other traffics where the throughout arrangements are not rationalised in the same way, and in the illustrations quoted there is obviously an ample flow of traffic to justify the specialised facilities provided.

One cargo imported in quantity and largely in chartered ships which has not made the same progress is timber and much of the sawnwood is still handled piece by piece on the ships and again on shore. A sawnwood ship may carry 150,000 or more pieces of timber, which gives an idea of the amount of labour involved. Experiments have been made with timber made up into packages which can be handled mechanically on shore and in fact some traffic passes in this way. Though there is bound to be a loss of stowage space in the ship one would think that a close study of this question might help to get rid of some of the seasonal congestion which often results more from lack of adequate clearance facilities than from slow discharge of the ships. In this connection it is interesting to note a recent newspaper report on the conversation of an Australian vessel to carry timber from Tasmania to the mainland ports in unit loads of 12 tons. Three 12-ton cranes were to be fitted to the ship with moveable platforms in the holds. These latter when loaded in the square of the hatch would be moved automatically to the sides of the ship. Although no figures were given of the estimated reduction in turn-round time the possibility of a reduction of up to 20 per cent in freight rates was mooted, which points to quicker and more economical working.

Handling of General Cargoes

Turning now to general cargo of the type normally carried by liners on regular services, it is obvious that there is the widest difference from bulk cargo. The term "general cargo" covers a high proportion of our exports other than coal, and some imports, and the goods may be in packages of different size, weight and shape, so that an infinite number of variations is possible. Fully mechanised handling is not practicable except for regular streams of traffic in packages of reasonable uniformity, and at the present time the greater proportion of this class of traffic is handled package by package on shore and again package by package in the ship as stowage proceeds.

In British ports the normal method of loading and discharging general cargoes to and from the larger class of vessel is by a shore based electric crane. There are exceptions where ship's gear is used and there are also specialised appliances for some trades. Similarly, loading to and from barges and lighters may be by ship's derrick. Nevertheless, in this country, although strangely enough, not in the United States, the portal or semi-portal type quay crane running on rails parallel with the quay has been used in increasing numbers since Lord Armstrong first applied hydraulic power in 1874. About the turn of the century electricity superseded hydraulic power and so for nearly a hundred years this type of appliance has been developed, and is now a highly efficient piece of machinery. All but tankers and a few ships built for special purposes have, of course, their own derricks which can lift in and out of every hatch and often a ship has a weight lifting capacity which the ordinary 3- or 6-ton quay crane cannot match. In some cases cranes are now being installed on ships instead of the traditional derricks, and although this gives a more positive movement the system of lifting to and from the hold over the side of the ship is still the same. Similarly a greater use is being made of the road mobile crane on shore, and there is little doubt that the mobility of this type of crane is to its advantage in ports where the vessels are suitable and quay utilisation is relatively low.

Although the basic system of handling the packages in the ship is little different from what it has been for many years, much export traffic is now put on pallet boards on arrival in the docks and remains there until taken from the pallet in the hold for normal stowage, intermediate movements being by fork lift or other mechanical truck. This method obviates the necessity for stowing the goods on the floor of the shed as one movement, and picking them up again to be barrowed to the ship's side for placing on a cargo board as the next. The number of handlings is reduced and the practice is both labour saving and quicker so far as the shore operations are concerned.

With the wide diversity of traffic carried it is impossible to give average speeds of loading and discharging, and what are quoted here are primarily to illustrate the wide difference which exists in any comparison with bulk cargoes. Probably for this country the loading figure for general cargo is about 12-15 measurement tons per gang per hour, or say about half that in weight. In some cases as high as 28-30 measurement tons per hour is reached, but to get to this there must be some long runs of suitable traffic, for discharge speeds will be higher according to the commodity and may vary from say 6 deadweight tons per hour up to 30 or 40 tons for packages convenient for rapid handling. Some improvement has been made since pre-war days where piecework rates have been introduced instead of time rates, and also where mechanical appliances have been introduced. Other factors have, however, militated against any considerable increase and on the whole the improvement has been small. Certainly no such wide success has been achieved as with bulk cargoes.

Containers and Shipboard Appliances

At the present time considerable interest is being shown in the development of containers which although introduced for internal transport by the predecessors of British Railways as long ago as 1926, are now only being seriously considered for long distance international traffic. On their Continental and Irish Services British Railways carry containers in considerable numbers and the vessels turn round in the day. Other firms do the same and there have also been considerable developments in the so-called "roll-on-roll-off" vessels. On the longer routes some use of containers is being made and refrigerated containers are also available. The development has, however, been small so far on the longer routes.

In the United States development has gone ahead more rapidly and special ships of considerable size have been built or converted for some regular services. These vessels—of the so-called cellular construction—are generally not suitable for carrying cargo other than containers of the appropriate type and size, and have special fittings which lock the containers into position in the hold. An outstanding example is the Pan-Atlantic line with services from New York to ports on the Gulf of Mexico which carries 226 containers of 23 short tons capacity. The vessels have three cranes of their own and the stowage is so organised that a container is taken aboard and another taken off with each movement of the crane. It is said that each ship can be loaded and discharged in 14 hours. The Matson Line on the Pacific coast and the Grace Line have also special container ships, and the latest of the Matson Line's fleet running from San Francisco to Honolulu carries 296 aluminium containers of about 24-ft. × 8-ft. × 8½-ft. below deck, and another 56 on deck. It is of interest to note that this Company started by converting six of its normal type freighters to carry 75 containers each on their decks.

The Grace Line have also converted ships for their service from New York to South American ports, and 476 containers are carried, the size being 17-ft. × 8-ft. × 8-ft.

While in the Matson ships the containers are lifted on and off by shore based appliances, the Grace Line vessels carry gantry cranes of their own, and a third method will be in use for vessels being constructed to run on the eastern Atlantic seaboard where about 170 containers are to be loaded and discharged through stern doors by fork lift trucks. In this case it is claimed that either loading or discharging can be completed in less than 4½ hours.

From this latter figure, which represents something approaching 500 tons per hour, and the figures quoted earlier for the Pan-Atlantic vessels where a rate of some 750 tons per hour is claimed, it would seem that speeds far in excess of normal methods can be reached. The figures will, of course, refer to short tons, but it must be remembered that they are achieved with a minimum of labour—in the case of the Pan-Atlantic service only three men being employed per crane, one driver and two men attending the trailers with the containers as they arrive and depart.

Of other appliances being developed it is interesting to note that the P. & O.—Orient Lines vessel *Oriana*, which sails on her maiden voyage shortly, will carry her own conveyor for handling baggage and stores to and from the shore. Stowed thwartship across the vessel the outboard conveyor can be extended either side and is connected with other conveyors running down the centre of the ship. Chain conveyors carry baggage and stores to any required deck, the man in charge pre-selecting the appropriate deck by push button control. It is believed that this is the first appliance of its kind, although shorebased conveyors have been used for many years.

Another device to be tried out in the new ship *Canberra*, is the cargo transporter which is in effect a boom housed within the ship with a moving carriage which has hoisting and traversing mechanism. When the ship is in port the boom is run out on rollers so that one end is over the quay and the carriage moves backward and forward with the load on a cargo platform. By this method hatch trunkage through the upper decks is avoided and the whole operation on the ship takes place under cover. There are also other advantages to the extent that the lifting and lowering movement is reduced and the load travels in a straight line, but the operation of stowing each separate package in the hold still applies unless the loads are containers or pallets or some other system of unit loads. A somewhat similar system on an American ship has been seen to work admirably loading cars.

Both these latter methods involve the use of side ports in the ship and these have been used for some time in certain coastal and near Continental trades where tidal variations are small. In these circumstances, pallets or cargo boards can be carried into the ship on fork lift or other trucks and where necessary be placed in position by a deck crane which plumbs the hatch.

Effect of Improved Methods

The figures quoted above can only be taken as a broad indication of what is being done but nevertheless it is clear that for bulk cargoes it is possible to achieve a rate of handling which can be expressed in terms of hundreds or even in some cases of thousands of tons per hour per gang, whereas for general cargoes one speaks in terms of tens of tons. In between these broad divisions there are many other commodities handled at different speeds, dependent on many different factors. Containers come fairly high on the list provided they do not have to be manœuvred by hand under the coaming, and where specially built ships are in use the discharging and loading times reported are exceptional.

With bulk cargo striking improvements have been made since pre-war days but with general cargo the advance in speed has been small, although mechanisation on shore and in some cases also in the hold has helped to reduce the labour effort required and keep down costs. Since the shipowner's objective is to keep his vessel on revenue-producing work at sea, the ultimate statistic is that of the ship, and the difference can be illustrated by figures quoted earlier this year at the Annual Shipping Lecture of the Institute of Transport when it was stated that few deep sea cargo liners can achieve less than 180 days a year in port loading and discharging cargo. The comparison was with a crude oil tanker which spent only 33 days working cargo. The comparison is striking and one is forced to the conclusion that even with all the efforts which have been and are being made towards improvement, the rate of handling of general cargo by the traditional method is never likely to compete with the mechanical handling of bulk cargo. In fact one is forced to question whether the pre-

sent methods of handling general cargoes are sufficiently in line with modern trends as even to make any real impact on the problem of turn-round.

Many people are now asking whether the container is a possible answer to the problem, and in this country where rails and manufactured steel work, and other products which are awkwardly shaped in relation to any type of packaging, make up an important sector of our exports it is difficult to think in terms of ocean-going vessels for containers only. There have, however, been considerable changes in recent years in methods of handling and one might quote sugar which now is dealt with as a bulk cargo and handled by grab. Some wines and sherry now travel in bulk while cement and gases and chemicals are also dealt with in this way. There will presumably be further changes of this kind and if stowing the goods in the hold of the ship is the bottleneck in the present system, in principle at any rate it would seem right to think in terms of making up unit loads at the factory, assembling them on the dockside and doing little more than securing them in the ship. Similarly in the inward direction, the unpacking and sorting to mark which now goes on in the dockside shed would be eliminated for any traffic in containers and, subject to the usual formalities, distribution would be both quicker and simpler.

To the shipowner, of course, containers are by no means an unmixed blessing. In shape containers are rectangular whereas the sides of the ship are generally curved to give seaworthiness and speed at a reasonable fuel consumption. There is, too, the expense and weight, and without a balanced trade it is possible that in one direction a large number of empties will be carried. Then, too, there are questions of standardisation and ownership. In fact, the difficulties seem to increase as the distance increases and whereas containers and pallets have proved themselves on the short sea routes it is only now that they are coming into use on the longer voyages. An American port authority was recently quoted as saying that while containers might still be regarded as optional on the longer sea routes they were now a must for coastal voyages. The tendency is similar in this country.

From the port operator's point of view containers will ease some problems and bring others with them. Problems of equipment and parking space are bound to arise and an important factor on which some people seem to be in doubt is whether or not the containers should be filled and emptied on the dock premises. Apart from any customs requirements, it would seem that to do so would completely vitiate most of the benefits which stem from the use of containers, and merely transfer the whole problem of handling on to the shed floor. Such a system would be expensive in both space and money, and in fact impossible on any considerable scale. It seems clear that the benefits of safe and speedy handling can only come from the throughout transit of goods in unit loads, and where full container loads for one destination cannot be made up at the originating point one would have thought that inland packing stations in busy industrial areas would be the obvious solution. Alternatively, it may be possible to devise small containers which fit together in multiples of 3 or 4 to make up one larger unit.

Whether or not it is possible for containers or any other alternative methods to be introduced is largely a matter for the shipowner, and it must be emphasised that cargo handling is only one of the problems to be faced when a ship is built. The shipowner is the only one who can attempt to assess the overall economic position and in many cases he will want his ship to be able to carry as wide a range of traffics as possible and to make use of many different ports. The advantages of specialisation are obvious, but equally there can be disadvantages.

Whether the answer to the problem is specially built ships for containers, or an increasing number of containers carried with other cargo, or any other new method, the port operators will clearly do their best to co-operate to overcome whatever problems arise.

In the meantime it is important that efforts to improve present methods should continue. The present problem is to a considerable extent a human one and there is no doubt that improvements are possible at all ports. New and radical methods might well help towards solving some part of this in that there should be greater regularity and security of employment. But even if changes are introduced a great deal of the work will continue to be done by traditional methods for many years. Much thought and time is being given to efforts to eliminate damage, increase speed, and reduce costs, and these seem to be worthwhile objectives.

Obituary

Sir John E. Thornycroft, K.B.E.

We deeply regret to record the death on 21st November last at the age of 88 of Sir John Edward Thornycroft, governing director and chairman of Sir John I. Thornycroft and Co. Ltd. and a well-known figure in the shipbuilding industry.

Sir John was educated at St. Paul's School and the Central Technical College in London where he gained his engineering diploma and the fellowship of the City and Guilds (London) Institute. He served his apprenticeship in all the shipbuilding and engineering departments of the Company's Chiswick Yard and from 1895 onwards, took an active part in the management of that yard, which was then engaged in the construction of steam torpedo boats and other high-speed craft. When in 1901 the family business was converted into a public company, he became managing director.

His interests, however, were not confined to ships. A good deal of experimental work on road transport had been carried out by the Company and this led to the production of a steam wagon, an oil engine tractor and finally to all types of road transport. The 1914 war provided a wider field for the technical activities of Sir John and his firm, and he was intimately concerned in the design and production of the first coastal motor torpedo boats, depth charge throwers and many other devices. In 1918 his war services were recognised by the award of the K.B.E.

Sir John had been president of the Institution of Civil Engineers, vice-president of the Institute of Naval Architects, president of the Institute of Mechanical Engineers and a member of the Institute of Transport, and was the author of several papers read before these bodies.

Quite apart from his life's work of shipbuilding and engineering, his interests were wide. His great vitality and a keenly enquiring mind, stimulated by his travels in the United States, South America, South Africa and many other countries of the world, resulted in there being few subjects on which he could not discourse with knowledge and authority.

Engineer-in-Chief to the Crown Agents

The Crown Agents for Overseas Governments and Administrations have appointed Sir James Farquharson, K.B.E., B.Sc.(Glas.), M.I.C.E., General Manager, East African Railways and Harbours, to the post of Engineer-in-Chief in their Office to succeed Sir Reginald Taylor, Kt., C.M.G., B.Sc.(Eng.), M.I.C.E., who retires on April 30, 1961.

Sir James Farquharson will be available in the same manner as his predecessor, to furnish the Colonial Office with engineering advice on matters of policy involving railways, harbours, public works, etc.; the engagement of specialist consultants, architectural and engineering; and the placing of engineering contracts.

Retractable Fender System at New York Naval Shipyard

Improved Type of Bracket Developed

By JOSEPH H. FINGER, Director, Design Division.
Public Works Department, New York Naval Shipyard.

The retractable marine fender system, originated at the New York Naval Shipyard about six years ago, has evoked much interest from those involved in waterfront engineering, following publication of the first descriptive article in the "Budocks Technical Digest" of June 1955. Subsequent articles in other technical publications, and gradual acceptance by those designing new piers or faced with the costly task of maintaining the conventional fender pile system, created even greater interest.

As the number of inquiries for additional information and the number of actual installations continued to increase, queries also reached this Shipyard on the feasibility of special applications. Study of these special applications soon indicated that the usefulness and merits of the system had not yet been fully exploited. Consequently, like most new developments, the original, or prototype, soon went through a series of changes as experience data and new requirements made their effect felt. It is the intent of this article to make known both the recent improvements and extended uses of the retractable marine fender system.

Although the basic principle of the fender system remains unchanged, the brackets supporting the system and providing the retraction, have been redesigned. This modification has actually opened new horizons for the usefulness and applicability of the fender system. One would naturally question how this is possible with so minor a change. This can best be explained by first referring to the illustrations, so that the change can be fully understood.

Fig. 1 shows a view of the face of a pier on which the new brackets have been installed. These brackets were fabricated from standard steel angles and plates, and are ready to receive the timber fenders which are being assembled at a nearby area on the pier. The post of the fender will have a pin through it at the top and bottom, which will rest in the "V" shaped brackets, supporting the fender system and providing an inclined plane on which it will slide under the pressure applied by the berthing vessel. Normally, the force of the vessel will cause the fender to move inward and upward, thus expending the major portion of the energy of impact, until it comes to rest against the pier structure. Should the pressure, however, be applied near the bottom of the fender (which would occur at extreme low tides) the lower portion will move inward and upward, while the upper portion will move outward and upward, on the extending leg of the "V". Stops are provided to preclude the rare possibility of the pins riding up and out of the bracket. Careful examination of Fig. 1 will show that the upper bracket extends out about 8-in. further than the lower bracket. This permits overcoming the existing slope of the face of the pier so that the new fender system will have a perfectly vertical exposed surface. The new bracket makes this important advantage relatively simple to achieve. Most important, however, is the fact that should greater energy absorption be necessary because of the size of the vessels to be moored, or the exposed location of the pier, the amount of retraction, directly related to the amount of energy to be absorbed, can be increased to 20-in. or more, as required.

Fig. 1

The additional advantage of doing more of the work away from the site under relatively ideal working conditions, made possible with the new brackets, has necessarily had its effect on reducing the initial cost of installation. The cost of repairs, although expected to be at a minimum, are even further reduced since the affected section can easily be removed, set at some convenient location, repaired, and placed back in its brackets. These features can readily be recognised from Figs. 2, 3 and 4, which show a section of fender being fabricated on the pier, being raised by a mobile crane and being placed in position in the brackets. It should be of interest to the cost-conscious engineer that on the job illustrated, 6-50-ft. sections, a total of 300-ft. of fender system, were set in place in six hours by three men and a mobile

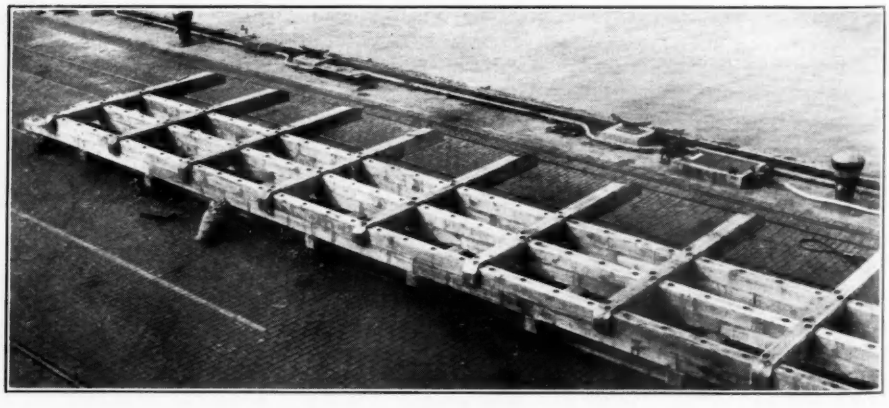


Fig. 2

Fig. 3

Fig. 4

crane. A general view of this completed section is shown in Fig. 5.

The use of the retractable fender on the corners of piers, first described in the March, 1957 issue of the "Technical Digest", has also been improved by the use of the new brackets. Experience at the Shipyard, where currents up to 3 knots are not uncommon, has indicated that the additional retraction possible with the new brackets is desirable. Whereas vessels forced against the corner of a pier which had 3-in. of retraction, fully retracted the fender system, where 6-in. of retraction was provided the system has hardly ever been fully retracted. This has quite logically led to the conclusion that 6-in. of retraction for corner fenders should usually be provided. For more exposed areas, the retraction can easily be increased up to 12-in., depending upon the degree of exposure. A typical section of corner fender, in the process of being installed, is shown on Fig. 6, while Fig 7, shows the completed corner of the pier.

Having successfully overcome the normal damage to which pier corners are frequently subjected, it was not difficult to realise that the corner fender could easily be adapted to overcome still another waterfront problem, the ferry slip. By continuing the 90° corner to a 180° curve, the typical ferry slip shown in Fig. 8 was developed.

Although studies on the design board and observations of actual installations indicated quite conclusively the advantages of the new brackets, several tests have been made to actually determine the capacity of this fender system to absorb energy, and to observe the general behaviour of the various members under different loading conditions. The interesting nature of the results obtained are best explained by a description of the tests, which follow:

Test 1—A jack was used to exert pressure on a contact post, at the point where the middle wale is connected. When a pressure of 10 tons was exerted, the posts on both sides of the point of application started to move. As the pressure was increased, additional bents started to retract until, with a pressure of 50 tons, the two adjacent posts had fully retracted and the fifth post on each side had moved $\frac{1}{4}$-in., with intermediate posts moving proportionate distances. A load-displacement curve for this test has been plotted on Fig 9.

Test 2—A similar test was performed using two jacks spaced 40-ft. apart. Readings were taken at 10-ton intervals with the pressure on both jacks the same. A load-displacement curve was also plotted for this test, as shown on Fig. 9.

It is of interest to note that both curves on Fig. 9 are straight lines, indicating that the resistance of the fender system to forces which act upon it, increases with the displacement. The tests also showed that four bents on each side of the point where the force was applied, combined with varying degrees of intensity, to resist the applied force. In the case of the test with the single jack, 36-ft. of the system of each side of the 50-ton force, or a total of 72-ft. of fender, came into play to absorb the energy imparted. From this we can better understand what happens when a vessel comes in contact with the fender system. The first point the vessel contacts, retracts a certain amount, allowing the other members of the fender to progressively contact the vessel, one after the other, each offering varying amounts of resistance, until the vessel comes to rest or the fender system retracts fully and bears against the pier structure. It is this flexibility of the frame which establishes many points of contact when the vessel is breasting against the fender, which also eliminates the possibility of any part of the vessel's hull being overstressed or the fender being damaged. Recognising how the fender system reacts to an external force, it is easier to understand how the elastic deformation caused by the stresses in all members of the system, namely wales, chocks, posts, and connecting bolts, absorbs most of the energy of

Fig. 5

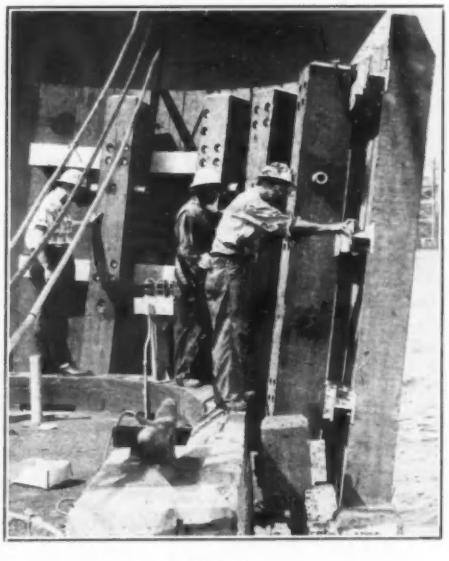


Fig. 6

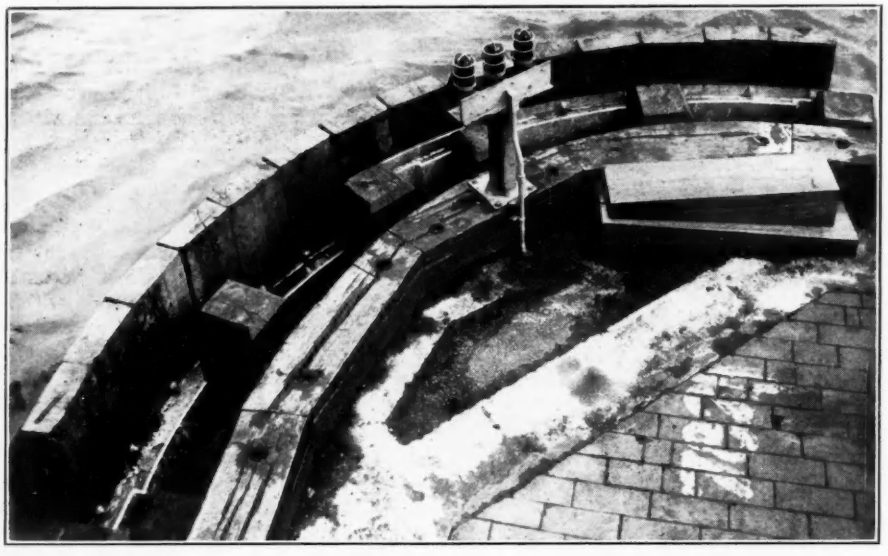
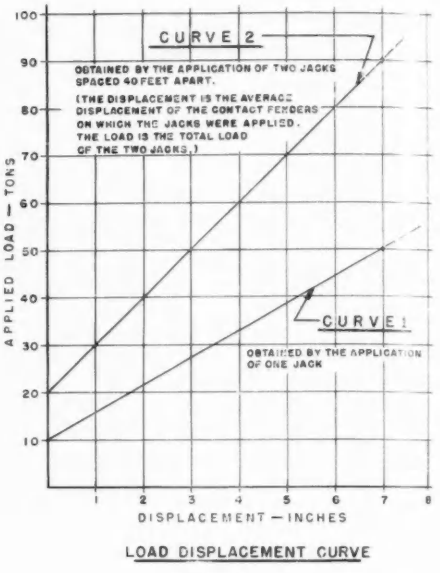


Fig. 7



LOAD DISPLACEMENT CURVE

Fig. 9

the acting force, leaving only a small portion of it as potential energy with the fender retracted in the upper position.

From the test results shown on the graphs in Fig. 9, more finite values of energy absorption can be determined. Using Curve 2 as an example, the area under the curve will give the amount of energy absorbed by the fender system when retracting a certain distance under a specific load. Since the area is comprised of the area of the triangle plus the area of the rectangle under the triangle, we get:

E=Area (triangle) + Area (rectangle)

$F=\frac{1}{2}\times 7\text{-in.}\times(90-20)$ tons
$+7\text{-in.}\times 20$ tons

$E=3.5\times 70+7\times 20=385$ in./tons

Considering that this force acted over a distance of 40-ft.:

$$E \text{ average}=\frac{385\text{-in./tons}}{40\text{-ft.}}$$

=9.6-in./tons per lineal foot of fender

To carry this analysis further, assume this fender system to be on a pier in a protected area with a vessel of 30,000 tons displacement, approaching the pier with a speed of 6-in. per second, perpendicular to the pier.

$E=\frac{1}{2}\,Mv^2\times C$

(C=coefficient used to compensate for the fact that the vessel is floating and is usually assumed to be 0.4 for deep draft vessels)

$$E=\tfrac{1}{2}\times 30{,}000 \text{ tons}\times\frac{(0.5)^2\times 12\times 0.4}{32.2}$$

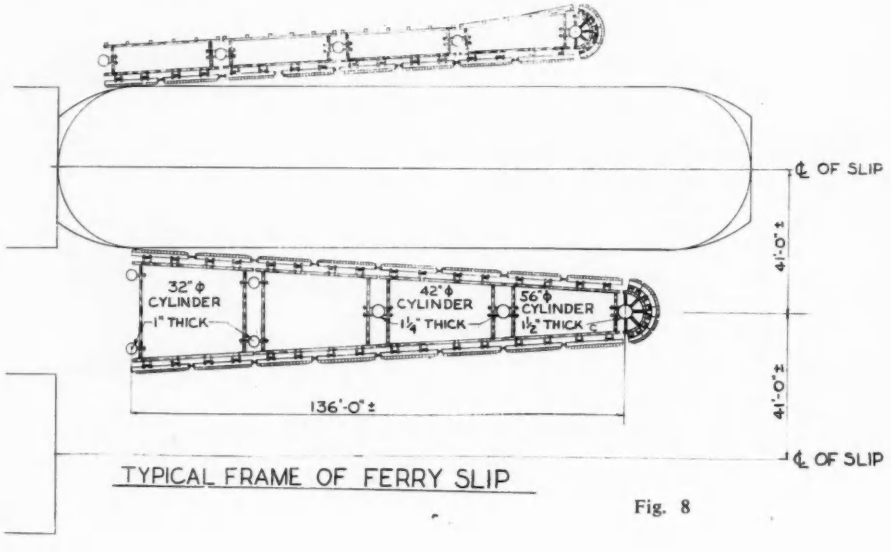
E=560-in./tons (kinetic energy)

Since the kinetic energy of the approaching vessel is 560-in./tons, and each lineal foot of the fender system can absorb 9.6-in./tons.

$$\frac{560}{9.6}=58.3\text{-ft.}$$

From the above, it can be seen that the 30,000-ton vessel, by contacting various points of the fender system within a distance of only 58.3-ft., can have its entire energy of approach absorbed and be brought to rest.

It is important to bear in mind, however, that this discussion on the ability of the fender system to absorb energy resulting from a static load, did not take into consideration a very significant factor. This is the friction developed at the contact points between the hull of the vessel being berthed and the fender system as the fender rides upward in the brackets. With a free body



TYPICAL FRAME OF FERRY SLIP

Fig. 8

Fig. 10

force diagram, omitted here for purposes of brevity, it can be shown that with a friction factor of 0.25, the horizontal force required to raise the fender is almost double that when only the friction in the bracket is taken into consideration.

Since the tests and the example given, considered only forces perpendicular to the fender system, the question of how the system will react to forces resulting from a vessel which approaches the pier at an angle, might logically be raised. Actually, the fender system can move parallel to the length of the pier, since the length of the pins are sized to permit some play between the ends of the pin and the sides of the brackets in which they rest. Thus, such a force would move the fender system sideways while it is also moving inward and upward. The ability of the system to overcome such forces is best exemplified by an actual incident when a destroyer approached a pier at an angle of about 45° with a force sufficient to actually shear off a section of the timber chocks, as shown in Fig. 10. Despite the magnitude of this concentrated force, no other damage was sustained by the brackets or the timber frame, which is still in service without any repairs whatsoever having been made.

Little wonder that the New York Naval Shipyard continues to receive inquiries from all parts of the world on what was once one of the most costly maintenance items to the waterfront engineer—the pier fender system!

Tides in Estuaries

With Particular Reference to the Thames

By M. R. ABBOTT, M.Sc.

This short note considers the tidal propagation in an estuary from an elementary point of view. The main purpose is to stress that the tide in an estuary is neither purely stationary (i.e. high water and low water occurring simultaneously throughout the length of the estuary) nor purely progressive (i.e. high water and low water travelling up the estuary with speed $\sqrt{gh}$), but in general is best thought of as the sum of two progressive waves, one landward, one seaward. It is shown that the tide in the Thames appears to be roughly a stationary wave seaward of Southend and then gradually changes in the next 10 miles upstream to become approximately a progressive wave.

1. Theory

Consider an estuary that has an undistorted tide; the most general form that such a tide can take is given by

$$\eta(x,t) = a(x)\cos\{\omega t - \psi(x)\} \quad . \quad . \quad . \quad (1)$$

where η is the height of the water surface relative to the mean level, a is the variable amplitude (half the range) up the estuary, $2\pi/\omega$ is the tidal period and ψ is the lag at any point. This equation is the best starting point for the present discussion since a and ψ, the two arbitary functions occurring, are the two parameters of the tide that are used in practice. ψ is usually given in hours and minutes of lag relative to the tide at the mouth ($x=0$ say with the positive x—axis upstream), and it is first necessary to convert this into degrees or radians by means of: 2π radians $=360°=12.3$ hours.

If we expand (1) by the usual addition formula of elementary trigonometry, we obtain

$$\eta(x,t) = a\cos\psi\cos\omega t + a\sin\psi\sin\omega t \quad . \quad . \quad . \quad (2)$$

$$= A_1(x)\cos\omega t + A_2(x)\sin\omega t \quad . \quad . \quad . \quad (3)$$

say, which shows that the tide can be interpreted as the sum of two stationary waves differing in phase by quarter of a tidal period ($=\pi/2\omega$) and with amplitudes $A_1=a\cos\psi$ and $A_2=a\sin\psi$. The physical meaning of this summation of two stationary waves is difficult to grasp. Alternatively, we can write

$$\eta(x,t) = a_1(x)\cos(\omega t - kx) + a_2(x)\cos(\omega t + kx). \quad . \quad . \quad . \quad (4)$$

and if

$$a\cos\psi = (a_1 + a_2)\cos kx,\ a\sin\psi = (a_1 - a_2)\sin kx. \quad . \quad . \quad . \quad (5)$$

then (1) and (4) are identical. The equations (5) are obtained by equating coefficients of $\cos\omega t$ and $\sin\omega t$ between (2) and (4). The value of k is fixed by: $k=\omega/\sqrt{gh}$, where h is the mean depth of the estuary. Thus, if we know the tide in an estuary in the form of (1) (i.e. the range and lag given) we can transform it to the form (4) by solving the two equations (5) for a_1 and a_2. In fact, we have

$$a_1 + a_2 = \frac{a\cos\psi}{\cos kx} = \frac{A_1}{\cos kx} \quad . \quad . \quad . \quad (6)$$

$$a_1 - a_2 = \frac{a\sin\psi}{\sin kx} = \frac{A_2}{\sin kx} \quad . \quad . \quad . \quad (7)$$

and by adding and subtracting these in turn we can obtain $a_1(x)$ and $a_2(x)$.

Equation (4) can be interpreted as the result of superimposing a progressive wave of amplitude $a_1(x)$ travelling upstream with speed $\omega/k=\sqrt{gh}$, and a progressive wave of amplitude $a_2(x)$ travelling downstream with the same speed. This, it is held, is the best way to regard the propagation of a tide in an estuary. It can be physically interpreted as follows: an incident wave $a_1\cos(\omega t-kx)$ travels upstream from the sea, its amplitude a_1 changes along the estuary due to the attenuating effect of friction and the amplifying effect of taper. Further, as this wave travels upstream, it suffers partial reflection from abrupt changes of section, sharp bends and perhaps from a weir at the upstream limit of the estuary, and all these partial reflections add up to produce a reflected wave $a_2\cos(\omega t+kx)$ which travels seawards with a varying amplitude a_2.

The amplitude of the reflected wave a_2 is often considerably smaller than a_1, especially in long smoothly tapering estuaries, and the tide then approximates to a single progressive wave $\eta=a_1\cos(\omega t-kx)$ travelling upstream. It is shown in §2 that the tide in the Thames is of this form in much of the estuary. On the other hand, if the estuary is relatively short and deep (i.e. gulf-like) there will be an appreciable reflected wave and the tide will resemble a stationary wave. When the upstream wave is perfectly reflected and the depth is sufficiently great for friction to be negligible, the tide becomes a single stationary wave. Since, if $a_1=a_2$, (4) becomes

$$\eta = 2a_1\cos kx\cos\omega t,$$

which is a stationary wave since high and low water occur at the same time for all x; though the amplitude $2a_1\cos kx$ does of course vary with x.

As far as estuaries are concerned, both the single progressive wave tide and the single stationary wave tide are idealisations that are not met with in practice, since though there is never perfect reflection there is always some. The most general sinusoidal tide can be regarded as the sum of the two progressive waves of (4), and the first is often considerably the larger and may in many cases be an adequate approximation. In practice, the presence of the reflected component of the tide has the effect of increasing the speed of propagation of the tide to above the $\sqrt{gh}$ of the single progressive wave, but less than the infinite speed of a stationary wave.

2. Application to the Thames

Data from the Thames estuary is now analysed along the lines of §1. We are mainly concerned with the 43 miles between Southend and London Bridge. Upstream of this section the tide is distorted through shallow water effects and its progress cannot therefore be discussed on the present theory. Seawards of Southend the estuary widens rapidly and quickly looses its one-dimensional character. The range and lag up the estuary are obtained from a comprehensive survey carried out for a tide on

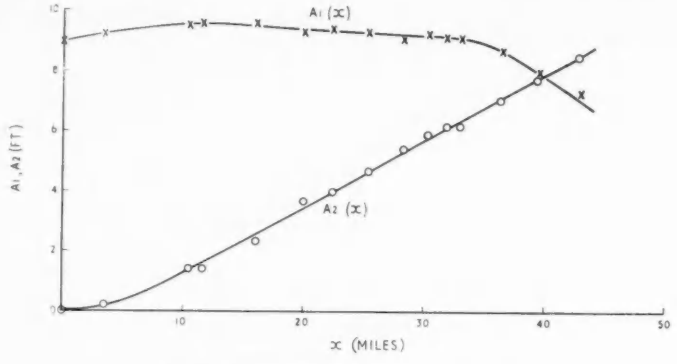


FIG 1 GRAPH OF A_1 & A_2 FOR THE THAMES

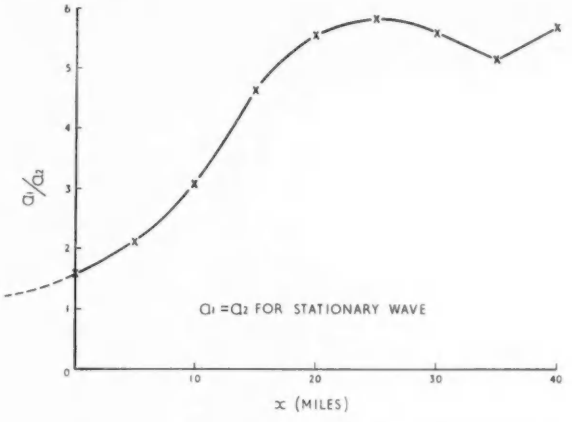


FIG 3. AMPLITUDE RATIO OF UPSTREAM & REFLECTED WAVES

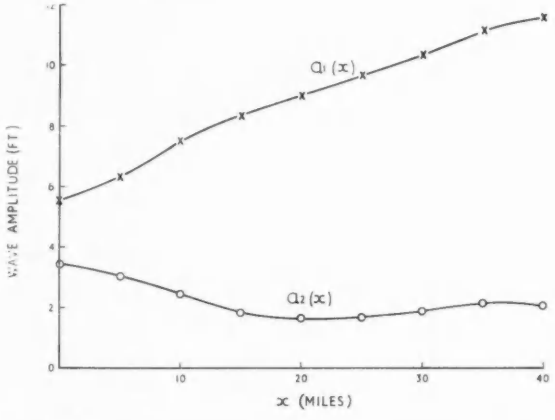


FIG 2. AMPLITUDES OF UPSTREAM (a_1) & REFLECTED (a_2) WAVES IN THE THAMES

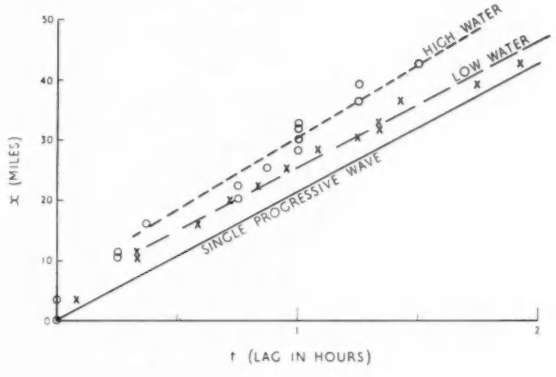


FIG 4. PROGRESS OF HIGH AND LOW WATER UP THE THAMES

November 2, 1948. Between $x=0$ at Southend and $x=43$ at London Bridge the tides were observed at 15 stations, and from measurements of range and lag at these points we can calculate $A_1=a_1 \cos \psi$ and $A_2=a_2 \sin \psi$ up the Thames. These functions are shown plotted in Fig. 1; it can be seen that they fall on to fairly smooth curves. These curves can be interpreted, it will be remembered, in a rather recondite way as the amplitudes of the two stationary waves which are equivalent to (1). The function A_1 and A_2 are hereafter assumed to be given by the smoothed curves of Fig. 1.

It is now possible to calculate a_1 and a_2 from (6) and (7). For simplicity we assume a constant mean depth of 30-ft. in this part of the Thames. Hence, taking $2\pi/\omega=12.3$ hours, h=30-ft. and A_1 and A_2 from Fig. 1, a_1 and a_2 are calculated and are shown plotted in Fig. 2. This shows that the amplitude of the upstream wave increases nearly linearly in the region considered, which suggests that the amplification obtained from the taper of the estuary is great enough to more than offset the attenuation due to friction and reflection. The amplitude of the reflected wave decreases at first and then maintains a roughly constant value for nearly 30 miles. In this latter portion, therefore, it seems as though in each section the attenuation due to friction and divergence (i.e. negative taper for this seaward wave) is approximately balanced by the energy reflected seawards from the upstream wave, Between $x=0$ and 10 miles there is an increase of the reflected wave, this is very probably due to the rapid narrowing of the estuary in the vicinity of Canvey Island. Further seawards still, the reflected amplitude appears to be only slightly less than the upstream amplitude, giving rise to a tide that resembles a stationary wave. This situation occurs since there is a rapid narrowing in this outer part of the estuary combined with a sufficient depth of water to produce only a small frictional force. There is thus a large amount of reflection and little friction: just the conditions which favour the occurrence of a tide of nearly stationary type.

The change up the estuary of the relative importance of the two component waves can best be seen by plotting the ratio of their amplitudes (a_1/a_2) as shown in Fig. 3. This shows that the amplitude ratio is 1.6 at $x=0$ and then increases steadily to a uniform value of about 5.5 from $x=20$ onwards. While extrapolating this curve seawards (i.e. for negative x) shows the tendency for a_1 and a_2 to become roughly equal in the outer estuary.

An alternative method of showing that in much of the inner Thames the tide can be regarded approximately as a single progressive wave, is to proceed simply from the observed phase lags. We can plot the progress of high and low water up the estuary as shown in Fig. 4. For $x > 10$ it is seen that both high water and low water travel up the estuary at approximately constant speeds. The line for a hypothetical progressive wave in water of 30-ft. mean depth is also shown. Past $x=10$ the three lines are nearly parallel, showing that the tide propagates approximately as a progressive wave. Nearly the whole of the displacement between the mean of the high and low water lines and the progressive wave line occurs in the first 10 miles, where, as stated above, there is a sizeable reflected component which has the effect of increasing the rate of propagation of the tide above the $\sqrt{gh}$ of a progressive wave.

The work described in this paper was carried out as part of the research programme of the Hydraulics Research Board of the Department of Scientific and Industrial Research, and is published with the permission of the Director, Hydraulics Research Station, Wallingford, Berks.

Repairs to West Wharf, Prince of Wales Dock, Swansea

By A. BROOKS, B.Sc., A.M.I.C.E., A.M.I.Mun.E.

Historical

In 1872 a Consulting Marine Engineer reported to the Swansea Harbour Trustees that further dock accommodation was necessary and recommended the construction of a dock, half tide basin and lock on the eastern side of the River Tawe. An Act was obtained in 1874 for the construction of the dock, but it was not finally constructed until 1881 when it was opened by the Prince of Wales (Edward VII) and named after him. In 1894 powers were obtained to enlarge and extend this dock and these works were completed by the 11th March, 1898. The area of this dock is 28 acres and it is nontidal. Normal depth of water is 28-ft. and water level is approximately 7-ft. below coping. The position of the Prince of Wales Dock relative to the Port of Swansea can be seen from Fig. 1.

Deterioration of the Wall

In 1955 it became evident that serious deterioration was taking place in the 650-ft. dock wall to the West Wharf. A considerable portion of the face stone work of "fitted rubble" below water level had become detached and fallen into the dock exposing the "rubble in mortar" interior of the wall. In addition the coping stones of the wall were being forced upwards and outwards, between mooring rings (these mooring rings were anchored by tie rods through buttresses built in the wall) also the dockside crane rail had moved outwards with the granite coping. A typical section of the wall prior to reconstruction can be seen in Fig. 2—the ratio of base width to height is 0.37 which gives a slender section. From the chemical analysis of a sample of the mortar taken from the hearting of the wall it was found that the original mortar was manufactured from hydraulic lime, sand and coke breeze and possibly coal ash or clinker. It is probable that the action of the dock water had leached out the uncombined lime and converted it to compounds of greater volume and percolation of the dock water had given rise to other chemical reactions resulting in disruptive forces being developed.

While the wall was obviously approaching a dangerous condition, there had been no bodily movement and no serious stability failure was apparent so it was decided to treat the problem as being mainly one of refacing the wall and of ensuring that the cavities in the wall were filled, any increase of stability obtained being of secondary importance.

The Contract

In 1958 a Contract was let to the Demolition and Construction Company for the repairs and improvements to this wharf. A section showing the nature of the work can be seen in Fig. 3; steel sheet piling was to be driven along the toe of the wall to a depth of 8-ft. below dock bottom and the space between the piling and the existing dock wall was to be filled with colloided concrete; an attempt was to be made to grout the existing wall and the rubble backing at the rear of the wall with cement grout. The whole wharf would then be topped and surfaced with concrete. The width of the wharf would be increased by 7-ft. 6-in. Work commenced in October, 1958.

Preliminary Works

Before pile driving could commence a considerable amount of silt and stone had to be removed from the toe of the wall, this work was carried out by a B.T.C. grab dredger and by diver using an air lift; in addition, the face of the dock wall above and

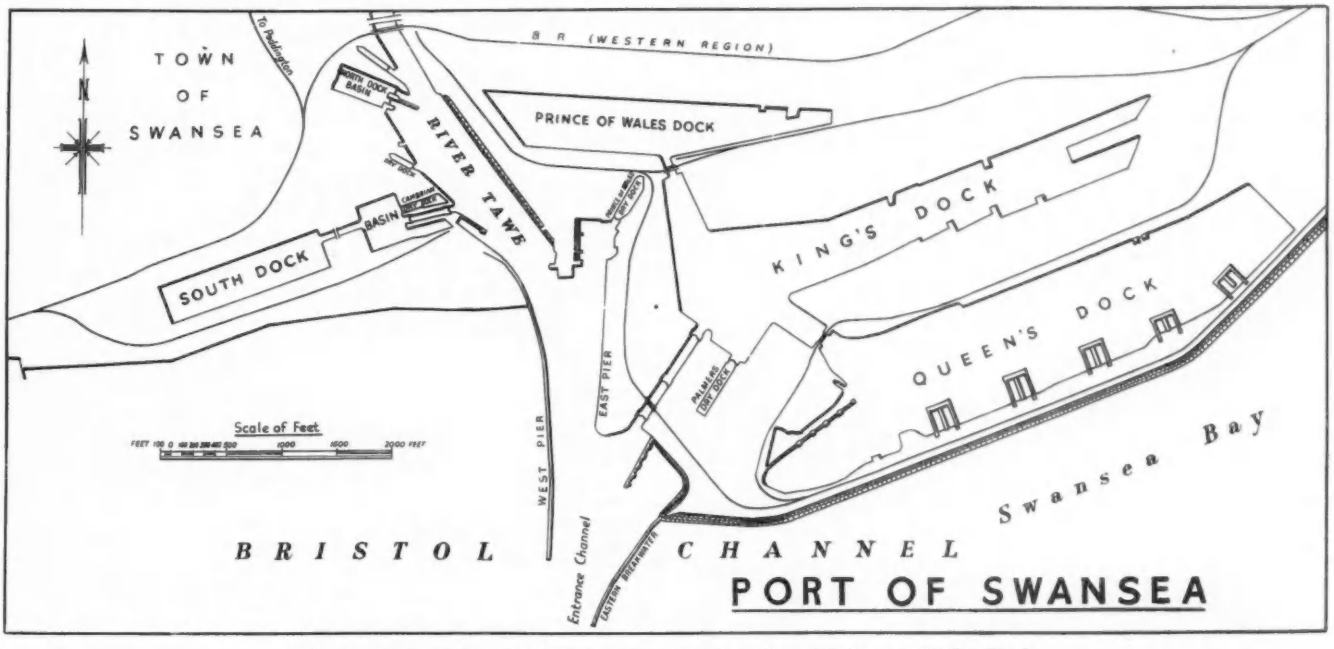


Fig. 1. Plan of the Port of Swansea showing site of Prince of Wales Dock.

below dock water was scraped free of marine growth, oil, and loose material to ensure a key between the colloidal concrete and the existing wall. The Contractors drove the piling—Appleby-Frodingham No. 2—through a timber guide frame cantilevered from the wharf with a McKiernen-Terry Hammer No. 7 suspended from an adapted 19RB. Excavator. The average set of the piling was approximately 10 blows to the inch.

As soon as 100-ft. of piling had been driven it was possible to commence placing the aggregate—2-in. - 4-in. pennant sandstone — and this was achieved by the delivery vehicles tipping the stone directly into the dock between the existing wall and the sheet piling. Immediately prior to the placing of the stone, 1½-in. diameter grout pipes were placed at 10-ft. centres between the wall and the piling and these were to be withdrawn as grouting proceeded.

Construction at the N. and S. ends of the Wharf

It was decided to extend the steel sheet piling up to the north and south return walls to present a uniform face and to act as permanent formwork, but this raised certain problems set by the curve of the toe of the wall in the internal angles and the need to affect a reasonable closure between the piling and the faces of the return walls. To avoid the difficulty of having to make this joint "grout-tight" with the consequent expensive underwater work, ordinary 1:1½:3 "tremmie" concrete was used in place of the colloidal concrete over a short length at either end. Fig. 4 shows the method of construction at the southern end. The last 18-ft. of sheet piling rests on the toe of the wall or against the face of the return wall; these latter piles were cut to match the profile of the wall and were then bolted to a 6-in. x 6-in. angle which was fixed by Rawl-bolts to the face of the return wall. Concrete bagwork was placed between the toe of the sheet piling and the stub piles which projected 2-ft. 6-in. above the nominal dock bottom and were 9-ft. 6-in. overall; concrete bagwork was also placed between the toe of the sheet piling and the existing wall. This ensured that there would be no movement of the toe of the pile during the placing of the concrete.

The double layer of 6-in. x 6-in. 8.65 lb/sq. yd mesh contained the concrete and kept it separate from the aggregate placed prior to the concreting—a vertical joint between the ordinary concrete and the colloidal concrete was considered necessary to reduce the possibility of the formation of air pockets during grouting. 71 cu. yd. of O.P. cement concrete, mix 1:1½:3, were tremmied into place at the southern end.

A similar method was used at the northern end but it was found possible to exclude the stub piles.

The Cement Grout and Plant

The grouting sub-contractors were the Prepakt Division, Millars Machinery Company Limited, who supervised the preparation and pumping of the "Prepakt" grout consisting of

Ordinary Portland Cement ...	473 lbs.
Pulverized Fuel Ash or Fly Ash	188 lbs.
Sand	820 lbs.
Water	300 lbs.
Intrusion Aid	3 kg. (6.6 lbs.)

The plant for the production of the grout was sited at the southern end of the wharf. The mixing of the constituents was carried out in a special purpose double drum mortar mixer—the drums being used alternatively. The water and Intrusion Aid followed by the cement, supplied from one of the two silos on either side of the plant, were placed in the mortar mixer and then the sand and fly ash were added from a 14/10 concrete mixer behind the mortar mixer where they had been weighed and pre-mixed. From the mixer the mortar was fed via a circular revolving sieve into an agitator consisting of an horizontally

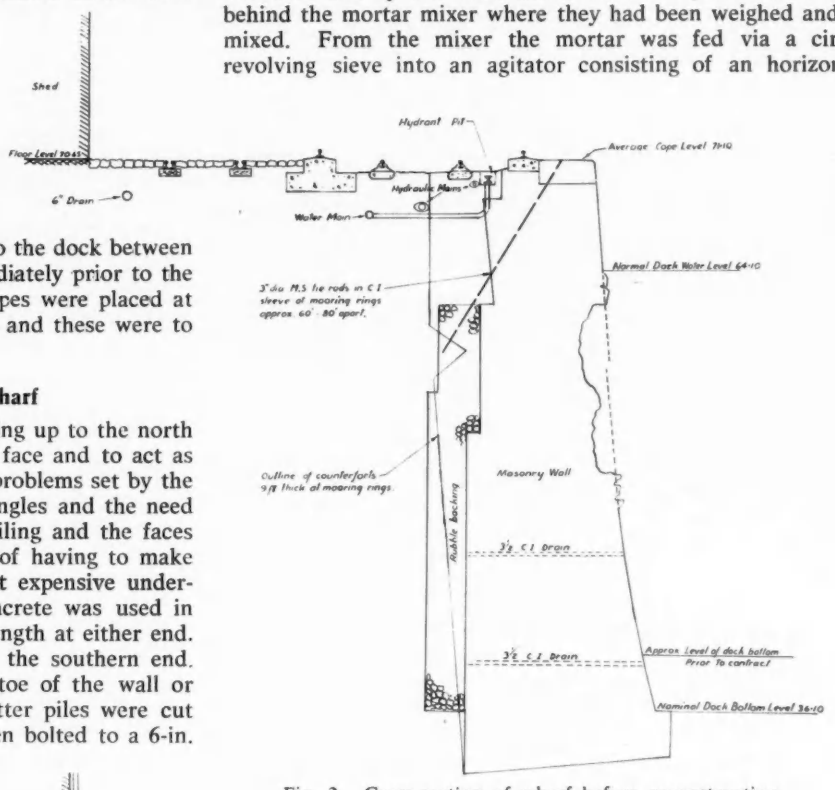

Shed
Floor Level 70·65
6" Drain
Hydrant Pit
Average Cope Level 71·10
Hydraulic Mains
Water Main
Normal Dock Water Level 64·10
3" dia. M.S. tie rods in C.I. sleeve at mooring rings approx. 60' - 80' apart.
Outline of counterforts 9 ft. thick at mooring rings
Masonry Wall
Rubble Backing
3½" C.I. Drain
3½" C.I. Drain
Approx. Level of dock bottom Prior To contract
Nominal Dock Bottom Level 36·10

Fig. 2. Cross-section of wharf before reconstruction.

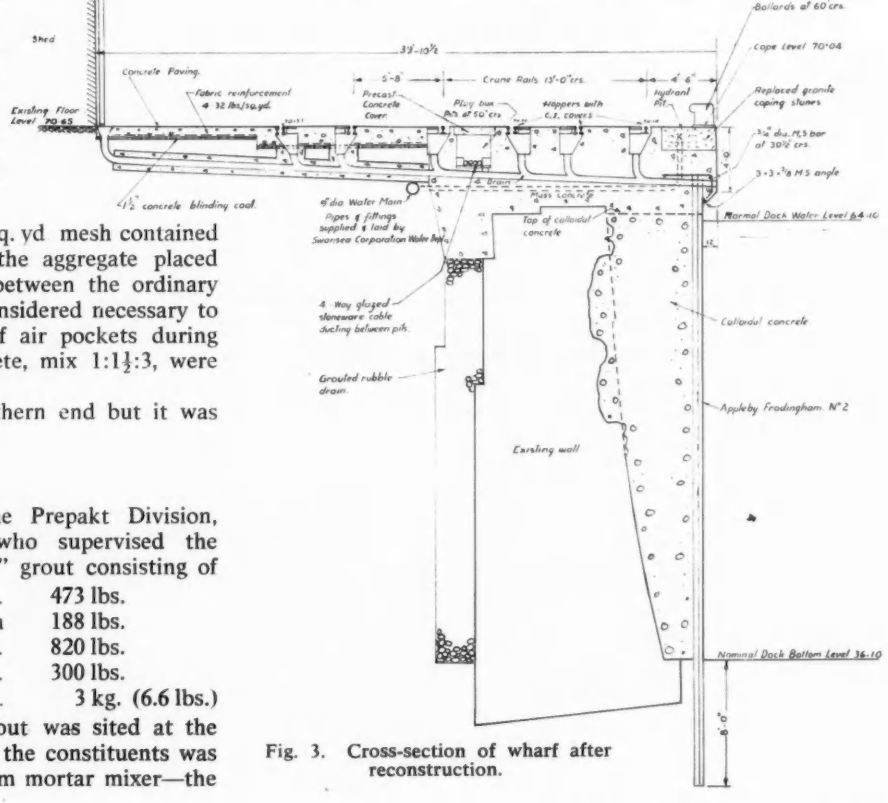
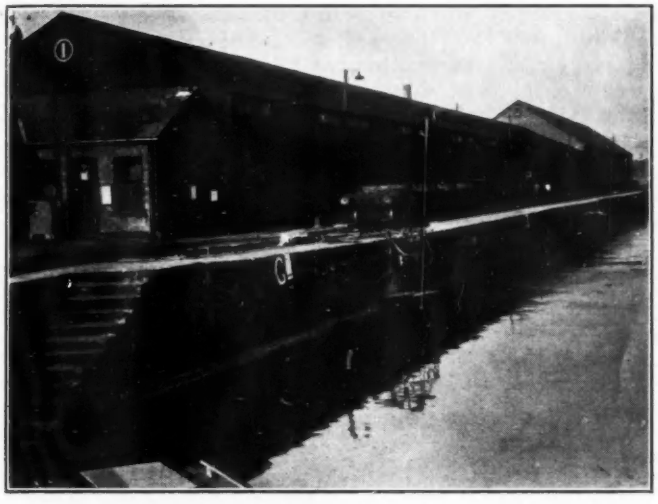

Shed
Existing Floor Level 70·65
Concrete Paving
Fabric reinforcement 4·32 lbs/sq.yd.
4½" concrete blinding coat
Precast Concrete Cover
Crane Rails 15'-0" crs.
Hydrant Pit
Bollards at 60' crs.
Cope Level 70·04
Replaced granite coping stones
¾" dia. M.S. bar at 30½" crs.
3 x 3 x ⅜ M.S. angle
4" dia. Water Main Pipes & fittings supplied & laid by Swansea Corporation Water Dept.
Top of colloidal concrete
Normal Dock Water Level 64·10
4 Way glazed stoneware cable ducting between pits
Colloidal concrete
Grouted rubble drain
Appleby Frodingham N°2
Existing wall
Nominal Dock Bottom Level 36·10

Fig. 3. Cross-section of wharf after reconstruction.



The condition of the wharf immediately prior to reconstruction.

mounted spindle with paddles attached revolving in a tank; at this stage the mortar could be inspected and tested to ensure it was of the right consistency. From the agitator, the mortar passed into the pump and hence into the header main.

Grouting

Immediately prior to the actual grouting, grout was pumped upwards into special 20 cms. x 20 cms. test moulds filled with selected 2-in. down aggregate and dock water and then covered with a layer of calico followed by a thin perforated metal plate clamped to the mould with a stand pipe and valve projecting upwards from the centre. With this apparatus it was thought possible to assimulate the actual grouting operation, for the use of the calico, perforated plate, and stand pipe ensured the grout were being pumped into the mould against a " head "; these cubes were then cured in dock water. The compressive strength of these cubes after 11 days was 2,275 and 2,311 lb./sq. in. respectively; in view of the delaying action on the hardening time of curing in the dock water and of the use of fly ash, these strengths were considered satisfactory, (the average strength of test cubes taken during construction was 2,963 lb/sq. in. after 28 days). The colloidal concrete expanded slightly during curing in dock water.

The wharf during the initial stages of reconstruction. The mesh dividing the " tremmie " concrete from the colloidal concrete at the southern end can be seen in the lower left-hand corner.

The grouting of the aggregate was commenced at the southern end of the wharf by pumping the mortar down the pre-placed pipes; the most satisfactory method was to grout down three pipes simultaneously and to raise the level of the grout slowly to obviate pockets formed by dust in the aggregate. The mortar found its own level and slope which was 1 in 3 and successive layers of grout were then laid down with the grout flowing northwards; by taking soundings in the pipes ahead of the grout pipes it was possible to know the exact limits of the grouted aggregate and to ensure that the top surface was being brought up uniformly and to withdraw the pipes as the grout level rose. It was considered essential that the following " lift " of grout should be placed within 72 hours of the preceding one but that a lift of colloidal concrete should not exceed 6-ft. to prevent undue pressure on the sheet piling. The total volume of colloidal concrete was 3,080 cu. yd. in which there was 1,414 cu. yd. of grout in 45 layers or " pumping days ".

Drilling and Grouting the Existing Dock Wall

Following the placing of the colloidal concrete an attempt was made to drill and grout the dock wall. The drilling Sub-contractors, Elmat Limited, using a drilling rig mounted on the rear end of a lorry drilled holes down into the wall with a diamond coring bit—3.595-in. outside diameter, 2.840-in. inside diameter. It did not prove possible to extract cores of the wall and this was

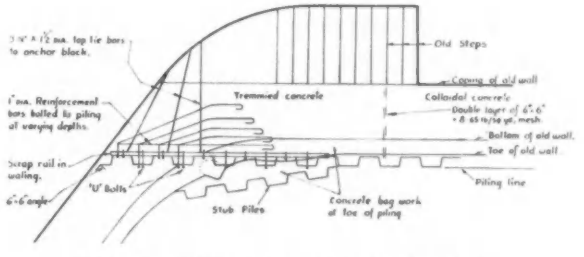


Fig. 4. Details of the corner of the wharf.

attributed to the weakness of the mortar and to the large proportion of 2-in. aggregate in the wall. Under the action of the drill the mortar broke down and emerged as a fine material, also the combination of " fines " and aggregate remaining in the core hole continually jammed the drill and made it difficult to place the grout tubes. Grout was pumped into these holes but the quantity of grout placed down each of the holes was negligible; an attempt was also made with grout-minus-sand but here again the quantity of grout placed was small.

Assuming that there were still voids in the old wall, it was apparent that this would not prove a practical method of filling them but, bearing in mind that the grouting of the colloidal concrete would undoubtedly have filled all voids accessible from the front and the grouting of the rubble drain would accomplish the same for those in the back of the wall, it was considered that this was of no great consequence and the attempt to grout the wall directly was abandoned.

Drilling the Colloidal Concrete

Cores, 2.84-in. dia., were taken of the colloidal concrete to determine its quality but here again difficulty was experienced in obtaining continuous cores and this was attributed to the aggregate size and to drilling before the mortar had hardened. Eventually better cores were obtained by delaying the coring until 21 days after grouting.

An attempt was made to obtain 6-in. cores but, while the three cores that were obtained were excellent, it did not prove possible with the equipment available to recover the cores from a depth greater than approximately 7-ft. as the cores could not be broken

off; this method was not pursued further.

A sufficient number of good cores were obtained to appraise the standard of the colloidal concrete and this was judged to be of good quality with few voids—the voids that existed appeared to be due to small but unavoidable pockets of accumulated dust.

Grouting of the Rubble Drain

The final grouting operation was the pumping of mortar into the rubble drain at the rear of the wall. The Main Contractors drove 1½-in. diameter grout pipes at approximately 8-ft. intervals along the line of the rubble drain to an average depth of 30-ft. A 50 lb. "jack" hammer was used for this operation and expendible shoes were formed from ex-service 2-in. shells "turned" to fit into the ends of the grout pipes; this was a satisfactory and economic method.

Grouting was commenced at each tube with the injection of a quality of neat cement/water paste and then the fly ash, followed by the sand, was added gradually to bring the grout up to the normal mix—this ensured easier pumping, presumably by "lubricating" the voids in the area immediately adjacent to the mouth of the grout tube. The average quantity of grout pumped down each of the 68 grouting points was 7 cu. yd. and evidence of the force and extent of the grouting was provided by the cracking of the surface extending some distance from the grouting point; the pressure at the grout pump was 125 lbs./sq. in.

The effect of the grouting and the upper limit of the grout were determined by redriving grout tubes into the line of the rubble drain at frequent intervals 7 days after grouting when it did not prove possible to drive the tubes more than 8-ft. below ground

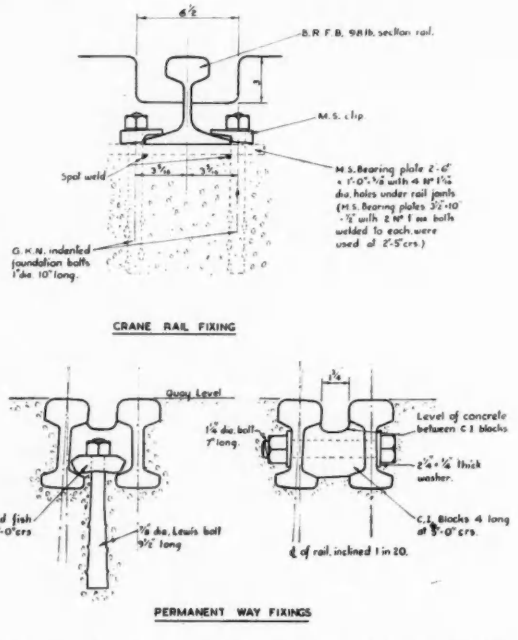

B.R.F.B. 98lb. section rail.
M.S. clip
Spot weld
G.K.N. indented foundation bolts 1"dia. 10" long.
CRANE RAIL FIXING
Gugy Level
1¼ dia. bolt 7" long.
Level of concrete between C.I. blocks
¾" standard fish plate at 5'-0" crs.
⅞ dia. Lewis bolt 9½" long
C.I. Blocks 4" long at 5'-0" crs.
℄ of rail, inclined 1 in 20.
PERMANENT WAY FIXINGS

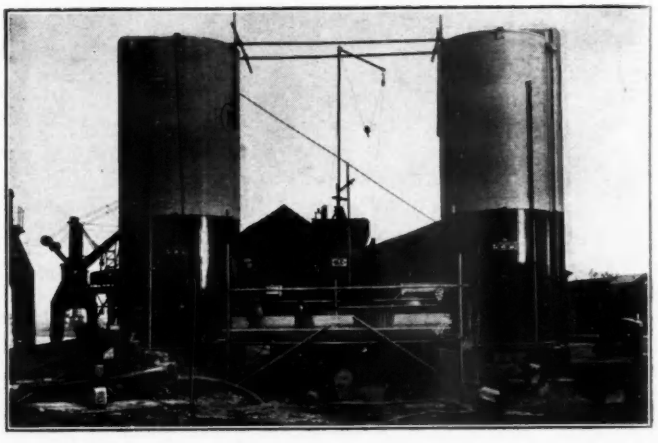
Fig. 5. Details of crane rail and permanent way fixings.

level, that is, they had reached the upper limit of the rubble drain as shown on the drawing Fig. 2; this was considered to be a satisfactory result.

Surfacing the Wharf

The mass concrete "cap" to the wharf was constructed in Class 'B' Ordinary Portland Cement Concrete to a mix designed by the main Contractors:— 1:2.74:1.57:5.49 by weight (cement: sand: ¼-in. - ⅜-in. limestone aggregate: 1½-in. limestone aggregate) combined aggregate grading No. 2, water/cement ratio 0.66. The average crushing strength of this concrete after 7 days wa 2,905 lb/sq. in. The reinforced slabs were constructed in Clas 'A' concrete to a nominal mix of 1:2:4. The average crushin strength of this concrete was 3,484 lb/sq. in.

The 98 lb. flat bottom crane rail and the secondhand 95 lb. per manent way rail, together with bolts, fishplates etc. were supplie by the B.T.C. These rails were held by holding down bolts a shown in Fig. 5. The Contractors supported these rail on concrete blocks in a trench, formed in the previous "lift"



The plant for the production of the grout. The "agitator" and grout pump are in the pit in the foreground.

into which the bolts hung; when the rails had been lined and levelled to tolerances of ±1/16-in., concrete was placed around the bolts and brought up to a level just over the bottom of the rail.

The surface of the concrete was given a "tamped" finish with the tamp marks running across the wharf. Dummy contraction joints were formed in the thin shed-side concrete slab only; they occurred at 30-ft. intervals at the construction joints across which the reinforcing was continuous; a bituminous filler was poured into 1-in. deep ½-in. wide recesses at the surface.

The work was carried out for the British Transport Commission under the direction of Mr. R. H. Edwards, M.I.C.E., the Civil Engineer for the South Wales Docks.

Traffic on the Kiel Canal

During the fiscal year ended March 31st, 1960, traffic on the Kiel Canal shows an 8.9 per cent increase compared with the previous year. Net tonnage rose by 4,460,000 tons to 38,193,000 and cargo was 12.3 per cent higher than the year before at 52,524,114 metric tons, which represents the first increase since 1956. Eastbound shipments, improving by over 4 million tons, accounted for 26,921,557 tons of this total while westbound shipments were over 1 million tons higher.

Of the various freights that passed through the Canal, coal, at 6,935,735 tons, was the only commodity to decrease as compared with last year. Commenting on this 6.6 per cent fall, the Kiel Canal Journal says "Further developments will show, however, whether this result is already a sign of the retrograde tendency of this kind of cargo among the energy generators." It may be significant that mineral oil and its derivatives showed an increase of 1.3 million tons, thus continuing an annual upward trend. Ore traffic also increased, eastward shipments totalling 3,622,131 tons, and was the second largest bulk cargo. Timber was the main bulk cargo to be shipped westward and rose by nearly half a million tons to 5,602,365 tons. General goods in both directions reached a monthly average of nearly 1 million tons.

Cargo Handling in Australia

Abstracts from the Annual Report of the Australian Stevedoring Industry Authority

THE Annual Reports of the Australian Stevedoring Industry Authority have so far been comprehensive and interesting documents. That for the year ended 30th June 1960 is no exception and, as would be expected, much of it is concerned with working conditions. Besides sections dealing with trade and finance, therefore, there are others covering recruitment, employment, amenities, accident prevention, mechanisation and, of course, delays and stoppages. The movement towards mechanisation was sustained during the year, the report states. There was increased use of pallets, containers and cargo boxes, more cargo was pre-slung and more mechanical equipment employed. Prepalletisation of, for example, butter and meat enabled the size of gangs to be reduced substantially and handling speeds to be increased. At Beauty Point the rate of handling butter rose from 10.8 tons to 17 tons and over per net hour. The following extracts from the Report amplify the comments made above and also include other details of general interest.

TRADE AND EMPLOYMENT

Tonnages and Man Hours

Statistics relating to cargo handled and to man hours worked on the various lines of cargo are obtained from employers who submit returns to the Authority for each loading and discharging operation requiring the use of waterside workers. With some cargoes, such as general cargo, waterside workers handle each package or unit load on the wharf and in the hold; with other cargoes, such as bulk grains and scrap metal, waterside workers may be required only to trim the cargo or to act as hatchmen while the cargo is being handled by mechanical equipment.

Compared with the previous year, the total quantity of cargo handled by waterside workers in 1959/60 increased by 5% and the total number of man hours worked decreased by 1%. The quantity of general cargo increased by 2%, iron and steel by 3%, timber and logs by 17%, flour by 16%, grains by 28%, and wool by 10% and the quantity of sugar handled by waterside workers decreased by 24%. Man hours worked on general cargo increased by 3%, on timber and logs by 17% and on wool by 13% and the man hours worked on iron and steel decreased by 13%, on sugar by 26% and on grains by 15%.

Grains and wool exported throughout the year and general cargo and timber imported in the second half of the year following the lifting of the import restrictions, accounted for most of the additional cargo handled by waterside workers. Interstate cargo declined mainly as a result of the smaller quantity of general cargo and sugar handled.

Rates of Work

The productive time gang rate of work is one measure of the operating efficiency of the gang, since it shows the relation between the quantity of cargo handled and the time during which this cargo is moving into or out of a vessel. Such rates of work depend on the nature of the cargo, the method of handling the cargo and its accessibility, the quality of the supervision, the method of measuring the cargo, the number of men in the gang and the method of classifying non-productive time. Large variations in rates are obtained for the same line of cargo at different ports and even at the same port for different vessels.

Except for iron and steel and timber, only small changes in average rates were recorded for the main cargoes. With iron and steel, the pre-slinging of cargo and the greater use of cranes accounted for most of an increase of about 5 tons per gang per hour in the rates of loading the vessel. Mechanised gangs are being used for the discharging of timber at Melbourne and Port Adelaide.

When the mechanical bulk handling equipment is used, fast rates of work are achieved with the use of a few waterside workers. Rates of loading and discharging are then expressed as gross ship rates. For example, at Fremantle, bulk wheat is loaded into overseas vessels at a rate of over 200 tons per hour using one gang of 18 men operating as trimmers and hatchmen; phosphates are discharged by the Osborne wharf bulk handling plant at Port Adelaide at a rate of over 500 tons per hour with an 18 man gang occasionally used for trimming; and at Burnie zinc concentrates are loaded at a rate of over 100 tons per hour with one hatchman only being employed.

It was announced in May, 1960, by shipowners that the freight on interstate general cargo was to be determined on a weight basis. It is anticipated that rates of work for general cargo expressed in weight tons will be lower than rates for general cargo expressed in measurement tons.

Average Gang Sizes

Average gang sizes vary not only for different cargoes but also for different ports. The average gang size for loading overseas general cargo at Sydney is 16 men, at Melbourne 17 men and at Port Adelaide 20 men.

There is evidence of a slight decline in average gang sizes over the past three years, particularly for gangs handling general cargo, paper, and iron and steel. The decline in gany sizes is associated with the greater use of mechanical equipment such as fork lifts, straddle trucks and cranes, and with the pre-slinging of cargo.

Non-Productive Working Time

At the ten major ports during 1959/60, 37.2% of gross gang hours paid for were non-productive of actual cargo movement into or out of a vessel. The highest non-productive time was 41.1% at Brisbane. The lowest was 33.4% at Townsville. At most ports there was a higher proportion of non-productive time during loading operations compared with discharging operations, while at each port overseas shipping encountered more delays to the movement of cargo than did interstate shipping.

"Weather," which includes paid gang hours unproductive as a result of rain, threatening rain, boisterous weather or extreme weather conditions, accounts for one-sixth of delays to cargo handling operations and has been the subject of many experiments with tents and other protective equipment. Port developments such as the inner harbour at Port Kembla, should reduce delays from boisterous weather. Protective clothing pools have been established at a number of Australian ports to enable work

to be performed in rain in accordance with the provisions of The Waterside Workers' Award, 1960.

Something like two-fifths of non-productive time results from delays associated with covering and uncovering hatches, moving beams, rigging, unrigging, changing or repairing ships' or shore gear and dunnaging, cleaning holds, lashing and unlashing cargo. Delays to interstate shipping from these causes amount to eleven or twelve per cent compared with between fifteen and seventeen per cent for overseas vessels. The higher percentages for overseas vessels largely result from the nature of cargoes handled, particularly refrigerated cargoes. Considerable reductions have been obtained under this heading when ships' crews have been employed on this work. Further savings would follow a greater use of provisions in the 1960 Award for the employment of short gangs for up to one half-hour at each end of the shift to do the preparatory and closing work such as the removal and replacement of beams and hatches.

Labour delays include placing labour, election of delegates and transferring from hatch to hatch and from vessel to vessel. Such delays amount to approximately 2% of gross gang hours worked.

Overseas vessels loading meat and freezer experienced delays amounting to 47.8% of gross gang hours of which a high proportion consisted of cargo delays and covering and uncovering delays. Delays associated with the loading of wool amounted to 44.3% for all Australian ports. At Sydney the percentage was 47.5 compared with 41.0 at Melbourne. Non-productive time in handling interstate general cargoes approximated 30% compared with 40% in handling overseas general cargoes.

Labour

The total number of registered waterside workers continued to decline during the year 1959/60, the registered strength falling from 23,041 to 22,045, a decline of 4.3%.

There was also a decline in total man hours worked by waterside workers from 30,175,087 to 29,912,276 which was a relatively smaller decline of about 1.0%. As might be expected this combination resulted in the weekly average hours for each waterside worker of the real labour force increasing 3.1% from 25.8 hours to 26.6 hours, with a rise in the average weekly wage from £16/19/3 to £18/13/3. The higher wage is also due partly to the increase of 6d. an hour in the Basic Wage from the 11th June, 1959, together with an increase in the waterside workers' margin of 4½d. an hour which was paid from the 14th December, 1959, and partly to the greater proportion of overtime rates.

The average daily number of waterside workers employed declined slightly (1.2%) but there was a significant reduction in the average daily number credited for Attendance Money from 5,183 to 4,154, a fall of 19.9%.

The increase in the number of men involved in disputes, mainly as a result of the all-port 24-hour stoppages, led to a small increase (6.1%) in the average number of daily unemployable labour, while the number of men with dormant registrations declined an insignificant 0.7%.

Average Weekly Hours per Waterside Worker of the Real Labour Force

	1957/58	1958/59	1959/60
Brisbane	19.9	22.5	23.6
Sydney	25.4	26.7	30.8
Melbourne (Cargo)	29.3	31.0	30.9
Port Adelaide	26.3	26.7	26.1
Fremantle	26.7	25.4	26.9
Hobart	26.7	26.2	26.7
Australian Ports	25.0	25.8	26.6

MECHANISATION AND IMPROVED METHODS

The importance of stevedoring-shipping efficiency, i.e. costs in Australia's overseas trade was emphasised by the growing importance of the Asian market, which, compared with Australia is based on a low-cost economy. It was reported that Japan had emerged as Australia's main market for wool, its second market for wheat and third market for sugar, was an important market for coal, and was receiving Australian mutton as well. Strong inquiry was received for Australian mutton from other Asian countries and from Middle East countries. Australia also exported rice to Hong Kong, and was stated to have prospects of establishing a permanent market there.

Stevedoring-shipping costs must also influence the price of imported goods and hence the Australian level of costs.

After referring to Bulk Handling and Liquid-Bulk Cargo, the Report turns to the use of Pallets and Containers and Preslinging.

There was increased use of pallets, containers and cargo boxes during the year, particularly in the interstate trade. In Melbourne, where interstate shipowners established a container pool during the year, there were 4,197 containers of 120 cubic foot capacity in the pool at the close of the year and a further 1,163 on order. These are additional to containers used permanently in particular vessels.

In what was described as the "unit freighting" method of shipping, interstate shipowners supplied steel cargo containers for the use of shippers. The use of steel cargo containers, which are weather-proof, meant less damage and loss through pillaging, swifter handling and less packaging, and lower insurance and consignment costs. It was claimed that the use of steel containers had reduced thefts and damage to interstate cargo on Sydney's waterfront by more than 90 per cent. A standard type of container could carry up to 52 cwt. cargo. Electric fork-lifts were essential in the ship's hold to handle containers.

Shipowners, in extending their container and strapped pallet cargo service during the year, announced they would maintain a weekly timetable co-ordinated service between major mainland ports. The experimental carriage of potatoes from Tasmania to Sydney in containers holding two tons proved successful.

Mechanical Equipment

In addition to an increase in the quantity of mobile mechanical equipment on the wharves, the year witnessed the introduction of additional specialised equipment. New mobile appliances were used at Hobart to facilitate the loading and the stowing both of fruit and containers. At Fremantle, two new 7½-ton cranes were erected at No. 4 Berth, North Wharf. At Port Pirie, front-end loaders were used in ships' holds for the trimming of zinc and lead concentrates for the first time in August, 1959, and met with considerable success. This preceded the use in January, 1960, of calf-dozers, which proved more efficient still.

At some ports, efficiency was improved by the concreting, or renewal of concreting, of areas about the wharves. This not only made for more efficient handling of mechanical equipment, but also made conditions more reasonable for drivers. Drivers of mechanical equipment were claiming, in some instances, that they were subjected to undue strain, because of the rough surface of areas over which they had to drive.

Developments at Townsville

Considerable interest attached to developments in mechanisation at Townsville, because, among other reasons, it is the port for shipping metals and concentrates from Western Queensland. New equipment introduced during the year expedited both loading and discharging of cargoes. The use of two new bulldozers

enabled two gangs to be employed on vessels loading concentrates, in place of one gang, thus reducing the turn-round for a 10,000 tons concentrate loading from 7 to 3½ days. Much of the new equipment was designed to handle specialised cargo from Mount Isa mines and its copper refining subsidiary at Townsville. Towards the end of the year ingots of blistered copper increased in weight from approximately 1 ton to 1 ton 14 cwt. Wire bars were strapped in bundles of approximately 1 ton and these and the copper ingots were both handled by minimum size gangs with the help of a fork-lift, loaded direct from semi-trailers under the hook, and stowed by battery powered units in the ship's hold.

An electric elevator for general purposes in ships' holds was installed by one stevedore, and experiments took place to ensure its most efficient use. This stevedore also experimented with a telescopic adjustable trestle for use in ship's holds.

Narrow wharf aprons with rough surfaces slowed work on general types of cargoes. Shed space was limited, and on many occasions stevedores had to commence discharge of a vessel into a shed which was congested with cargoes from earlier ships. Lighting on wharves was poor, causing delay in sorting and stacking, which frequently held up the discharge of cargo. The continued installation of the old type of rail-point levers obstructed mobile units used on the wharf.

Meat Loading

Two associated developments aided efficiency in meat loading. These developments were the shipment of beef in pre-palletised cartons, and the introduction, towards the end of the year, of a new type of tubular steel pallet with detachable sides, which handled two tons of the cartons. The first shipment of pre-palletised cartons of frozen beef was loaded in Brisbane in August, 1959. The success of the method led to its widespread use. Pre-palletising by meatworks' employees reduced the number of shore hands employed per gang of waterside workers from six to two. Preliminary inspections indicated that the loading rate was also improved. Cartons of canned beef were also handled by the same method. At Gladstone, the new system proved a marked success.

At Bowen, the use of this method to handle cartons of frozen beef in pallets carrying two tons of cargo increased the amount of cargo loaded during a shift; the size of gang normally employed under the conventional loading method was reduced from 19 to 15 men and there were no rail or shunting delays, as the palletised cargo was taken from the meatworks to the wharf by road transport. At Bowen it was noted too, that the use of fork-lift trucks to handle frozen meat cargoes enabled a greater area on the wharf, adjacent to the ship being worked, to be utilised. The use of rail waggons in this work had previously contributed to congestion on the wharf, and delays.

Mechanical Training

The Authority conducted schools at Launceston, Burnie, Albany, Fremantle, Darwin, Newcastle and Sydney, at which waterside workers were taught to drive winches and handle mechanical equipment, throughout the year.

In dealing with employment and mechanisation in the stevedoring industry, the total problem of employment and desirable economic activity throughout Australia must be kept in mind. The Authority has previously pointed out that failure to mechanise, in the Australian coastal shipping trade, could only result in business and employment going to competitive land transport, and in international trade, in Australian products being priced out of the market.

Mechanisation or automation in stevedoring can lead to increased employment in the particular industry stevedoring serves, and to desirable economic activity, which stimulates employment generally. The buoyancy of the Australian economy is affected by the level of exports and imports, which level in turn must largely decide the amount of employment for waterside workers.

SPECIAL STUDIES: MEAT LOADING

For the purposes of determining the extent of delays suffered by meat loading vessels and the reasons therefore, a time and motion survey was conducted at Bowen during June, 1960, on the loading of two freezer vessels, namely:

(1) **"Rockhampton Star"—from 9th to 12th June:**
Loading frozen quarter beef and cartons of boneless beef for London and Liverpool. This vessel lifted the first meat of the 1960 killing season.

(2) **"Citos"—12th June, 1960:**
Loading cartons of boneless beef for Kobe.

No particular significance attaches to the selection of Bowen for this survey, and it is proposed to conduct similar studies at this and other meat loading ports in the future. All parties affected were given prior notice of the proposed survey.

During the survey, observers were placed at the loading points at the Meat Works, which included the assembly point for conveyance to the jetty, the shunting yards adjacent to the jetty, and the jetty and the ship.

The statistical analysis for the "Rockhampton Star," computed from data recorded during the survey, shows a total of 41.4% of the total hours worked on meat loading as non-productive time (paid working time which does not produce any movement of cargo). The break-up of this time is as follows:

	Non-productive Gang Hours	Percentage	Average July, 1959, to March, 1960 (Meat vessels only)
Rest Periods—Award (15 mins.)	6.00	5.8%	5.3%
Rest Periods—Excess	1.73	1.7%	—
*Unused part of minimum ...	8.37	8.1%	0.9%
Changing, issue of aprons ...	4.43	4.3%	4.0%
Pay Period	0.62	0.6%	0.2%
Weather	—	—	1.3%
Cover and uncover holds (tarpaulins) ...	1.37	1.3%	11.2%
Rigging, etc., Ships' Gear ...	2.04	2.0%	2.6%
Rigging, etc., Shore Gear ...	8.61	8.3%	6.9%
Dunnaging, etc.	—	—	0.5%
Cargo delays	5.78	5.6%	2.5%
Shunting	0.33	0.3%	4.1%
Berthing delays	—	—	0.4%
Labour delays	3.50	3.4%	1.7%
Disputes	—	—	0.1%
Totals ...	42.78	41.4%	41.7%

*Time not worked but paid for under the Award.

The analysis for the "Citos" loading is as follows:

	Non-productive Gang Hours	Percentage
Rest Periods—Award	1.00	6.1%
Rest Periods—Excess	0.38	2.3%
Unused part of minimum ...	0.52	3.2%
Changing, issue of aprons ...	0.68	4.1%
Rigging—Shore Gear	1.50	9.1%
Dunnaging	0.30	1.8%
Shunting	—	—
Cargo delays	1.23	7.5%
Labour delays	0.92	5.5%
Total ...	6.53	39.6%

It should be noted that although non-productive time on meat loading at Bowen is higher than is desirable, it is lower than the Australian average and other ports where this type of cargo is loaded. This is illustrated in the following table:

Non-productive Time Percentages
Meat Loading 1959/60

Main Australian Meat Loading Ports ...	48.3%
Bowen	41.4%
Sydney	50.9%
Brisbane	48.9%
Melbourne	50.6%

SAFETY OF WORKING GEAR AND ACCIDENT PREVENTION

The outstanding developments with regard to safety in stevedoring operations during the year were:

(1) The setting up by the employers of the accident prevention organisation fore-shadowed in the last Report; and

(2) The inclusion of new safety provisions in the Waterside Workers' Award judgment handed down by Ashburner, J. on 7th October, 1959.

Under the employers' accident prevention organisation, State Superintendents have been appointed at Sydney, Melbourne, Brisbane, Adelaide and Fremantle. As the scheme develops further appointments will be made. Lectures on all phases of safety and accident prevention are being given to supervisors and foremen at these and adjacent ports.

A wide variety of safety posters are being displayed around the wharves in many ports throughout Australia. A standardised system of accident reporting has been introduced at some ports. It will eventually apply to all ports. It is hoped that these reports will provide valuable information and statistics on the factors which are responsible for the high accident rate in this industry. This type of data will also make it possible to plan preventive measures.

In addition to the port-wide employers' organisation, one employer, the Victorian Stevedoring and General Contracting Company Pty. Limited, continues to employ its own full-time safety officer. This is a commendable step foward in accident prevention. The officer in question has the benefit of close personal contact with the supervisors, foremen and gearmen employed by this company, and can keep strict supervision on its gear and eliminate other accident hazards.

A further step in the drive for safety was the inclusion of a clause in the recent Waterside Workers' Award which provides that:

> "When a bona fide safety issue rises on any job and the employees concerned request a Board of Reference in accordance with clause 28 (c) (v) of this award, such employees need not work pending determination of the issue by the Board. Provided that if the Board decides against the claim the men concerned shall not be paid for the period during which they were standing by, but if the Board supports the employees' contention the period during which the men concerned were standing by shall be paid for."

Although the foregoing developments have helped in the drive for safer conditions of working on the waterfront, a tremendous amount of work still remains to be done in this field.

The Authority is still most concerned at the increasing number of instances reported to it of vessels attempting to work cargo with gear which is unsafe. This applies to both overseas and Australian-owned vessels.

Another very disturbing feature is the failure by some stevedoring companies to report accidents as soon as they happen and so enable an immediate on-the-spot investigation to be made. In some cases, this delay has prevented any inquiry at all, for the vessel has sailed before the report has been received. In others the only report of the accident received by the Navigation Department's Inspector comes from the Authority's Inspector.

Industrial Matters

This is by far the biggest section of the Report. In the main it deals with appeals against suspension or cancellation of the registration of waterside workers for a variety of types of offence. These included assault, being under the influence of liquor, failing to report back to the job, pillage, refusing to obey instructions, returning to work late, insolence and refusing to work. High Court cases reported included one for fraudulent claims for sick pay and another where the validity of a compulsory "political" levy imposed by the Hobart Branch of the Waterside Workers' Federation was challenged.

TIME LOST THROUGH INDUSTRIAL STOPPAGES

During the year, 806,133 man hours were lost as a result of industrial stoppages. This total is 2.7% of the total man hours worked and is more than double the total for the past year. However, this loss is only slightly less than half that of the preceding two years.

The main feature this year has been the large proportion of time lost due to 24-hour stoppages. This total of 381,784 man hours was 47.4% of the overall loss and was considerably in excess of the loss for any other type of industrial stoppage. Last year 39,944 man hours were lost in 24-hour stoppages which represented only 11.6% of the gross total.

There were three Australia-wide stoppages, one in December, 1959, which was held to discuss various claims of the Federation for margins, long-service leave, etc., including certain clauses of the new Award. The other two stoppages were in connection with the Sunday work dispute at Melbourne, one in April, and one in May.

Refusal to work on Sundays at Melbourne accounted for the next highest proportion of time lost, 116,846 man hours or 14.5%.

Port Adelaide was the only capital city port where the loss of man hours through industrial disputes was substantially below the Australian ports' average of 2.7%. The loss at Port Adelaide was 21,723 man hours which was 0.9% of the man hours worked at the port.

DELAYS IN STEVEDORING OPERATIONS ATTRIBUTABLE TO EMPLOYERS

As required by Section 57 of the Stevedoring Industry Act 1956-1957, the Authority published each month during the year a report giving particulars of:

(a) stoppages of work by registered waterside workers during that month; and

(b) delays in the performance of stevedoring operations during that month due to the failure of registered employers to comply with a provision of the Act, of an order or direction of the Authority or of an award of the Commission.

The delays falling within (b) above which were included in these reports numbered 35 and resulted in a total loss of 2,673 man hours.

More than one-third of the total loss—922 man hours—resulted from delays at Melbourne (4) and Port Adelaide (2) when transfers of waterside workers from one vessel to another were prevented because employers either gave incorrect information regarding the time of discharge of waterside workers, or failed to notify the Employment Bureau of the finishing times of waterside workers. Other major losses occurred at Port Kembla in July,

1959, when 132 man hours were lost as a result of a dispute over a safety issue in which the Navigation Inspector ruled against the employer; at Hobart in May, 1960, when 123 man hours were lost through an employer failing to give the customary notice to waterside workers that they would probably be required to work overtime that night, thereby preventing their employment on transfer after 5.00 p.m.; and at Newcastle in June, 1960, when 147 man hours were lost through an employer failing to ensure that: (a) hatchboards fitted properly; (b) two ladders were in good order and (c) a brow of cargo was safe for working.

Each of the delays was considered by the Authority with a view to prosecution procedings under Section 33 of the Act. One case was referred to the Crown Solicitor with instructions to prosecute if, in his opinion, a prime facie case could be established. In two other cases warnings were issued.

FINANCE

During the year ended 30th June, 1960, the rate of levy, under the stevedoring Industry Charge Act 1958, remained at 2/6d. per man hour.

The revenue derived from this levy amounted to £3,718,173, which was £854,103 below the receipts of the previous year, when the rate of levy was 3/- per man hour and about 300,000 more man hours were worked.

Conversely, the total expenditure of the Authority continued to increase and for this year it was £806,794 in excess of the previous year.

There were three main causes for this steep rise, namely, Ashburner J.'s determination that, from 1st July, 1959, the Authority would assume responsibility for all Annual Leave payments to waterside workers; the basic wage increase of 15/- per week granted in May, 1959, and a marginal increase of 4½d. per hour which was granted to waterside workers in December, 1959. The basic wage and marginal increases had an immediate effect upon disbursements for Sick Leave, Holiday Pay, and Annual Leave.

For the full year, total expenditure exceeded revenue from the levy by £438,433. However, this deficit was covered by funds amounting to £633,089, accumulated in the previous year.

Income:

Revenue from Levy	£3,718,173
Receipts from Shipowners' Annual Leave Fund	755,000
Interest on Investments	9,056
Total Income	£4,482,229

Expenditure:

Attendance Money ... ... (being 32.9% of total expenditure)	£1,384,806
Sick Leave ... ... (being 7.9% of total expenditure)	326,023
Statutory Holiday Pay ... ... (being 15.4% of total expenditure)	638,749
Annual Leave ... ... (being 24.9% of total expenditure)	1,036,165
Other payments to or for Waterside Workers (being 1.0% of total expenditure)	34,941
Services and Amenities for Waterside Workers (being 3.9% of total expenditure)	155,453
Total payments to or for Waterside Workers	£3,576,137
Administration, including labour bureau operations, sundries and adjustments .. ... (being 14.0% of total expenditure)	580,469
Total Expenditure	£4,156,606

Excess Income over Expenditure of £325,623 for the year ended 30th June, 1960, was £900,317 less than the previous year.

The financial position of the Authority at the close of the year was sound, due principally to the fact that between January and June, 1960, an amount of £755,000 was received from the Shipowners' Annual Leave Trust Fund to cover, in part, the liability for accrued Annual Leave amounting to £1,080,000 imposed on the Authority on 1st July, 1959. As mentioned earlier this additional revenue has enabled the Authority to maintain the current rate of levy throughout the year.

The Control of Spartina Grass in Tidal Estuaries

Advantages of the New Chemical Herbicides

By ERIC HARDY

The vegetation of inter-tidal mud-flats has an important influence upon the deposit of silt screened from the tidal flow, and the resultant increase of bank-level, bringing in its wake increased silting of the area and reduction of the speed of flow. This in itself would be resolved more easily were it not for the natural changes in vegetation and the appearance and colonisation of estuarine banks by newly-arrived species. One of the most notorious species in this respect, which in modern times has appeared on many British and other mud-banks, is the cord-grass *Spartina townsendii*. Left unchecked, this vigorously-growing species attains dominance in the ultimate " climax flora " due to its ability to grow while submerged for several hours each tide, and to increase itself, and the banks, by the binding action of its perennial and creeping rootstock. Furthermore the author has noticed that where it has become abundant in estuaries, like the Cheshire banks of the Dee, producing an abundance of its large spikelets of seeds, that these attract flocks of house sparrows to feed on them and further distribute the seeds in their droppings.

In pre-war years *Spartina* beds were destroyed on mud-banks which they had colonised, in places like the River Mersey, by the use of copper sulphate poisons. Under the new Clean Rivers (Estuaries and Tidal Waters) Act which came into force on September 29th last, much greater powers are held by Rivers Boards with regard to the use of chemicals detrimental to local fisheries than when an article describing this plant was published in the December 1940 issue of the " Dock and Harbour Authority."

At the Nature Conservancy station at Wareham, Ranwell and Downing have recently experimented with the use of the American weed-killer dalapon, chemically 2.2 dichloropropionic acid, which is absorbed by both roots and leaves of grasses from underground contact.

Large areas conquered by *Spartina* around the British coasts have been at the expense of another low-tide seeding plant, the eel-grass or *Zostera* which was greatly reduced by fungus disease a quarter of a century ago. *Spartina* has tended to spread over muds previously occupied by *Zostera*, but this is not always the case. In the Dee Estuary, the ancient, defunct Port of Parkgate (whence Handel sailed by packet-boat to Ireland for the first performance of his Messiah) has long been closed by silting due partly to the extension before the war of the common sea-samphire, *Salicornia stricta*, also known as saltwort. Since the war, however, *Spartina townsendii* has intruded into this plant community, and steadily

outgrown the *Salicornia*. It has further spread to other parts of the estuary as far as Hoylake at the mouth and the Shotton-Flint marshes of the upper estuary, whereas *Zostera* has never been anything but the rarest of Dee estuary plants.

The Dorset experiments have shown that dalapon used at 50 lb./A gave a 100% kill of *Spartina* growth one year after July spraying. Re-invasion by seedlings, however, indicates the need for repeated applications to keep the weed under control. Another treatment with fenuron at 40 lb./A gave a 99% kill when sprayed in April, and there was no significant regrowth of the plants a year and a half after application. A 60% destruction of the weeds was obtained on the tidal stretches by sprinkling on the mud surface, or injecting into the mud, pellets comprising fenuron, 2, 4-D and sodium borate at 15 lb./Acre.

In America, the chief herbicides used to control aquatic weeds are benoclor, 2, 4-D, solvent naphtha, CMU and sodium arsenite. In tidal areas quick destruction or quick absorption is necessary before tidal dilution, and, where sea-fisheries exist, some chemicals like the latter would be too toxic. Dalapon and amitrol have been shown by Levi in Australia to be satisfactory in controlling growth of *Typha* (reed-mace), rushes and sedges in freshwater channels with fluctuating water-levels. Amitrol gave complete control for at least 15 months, and the ethyl ester of 2, 4-D applied at the rate of 16 lb./A in oil emulsion gave good control of narrow-leaf *Cattail*, especially when used on the 5 to 7-leaf stage of growth and when water levels could be maintained at 3-ft. after treament.

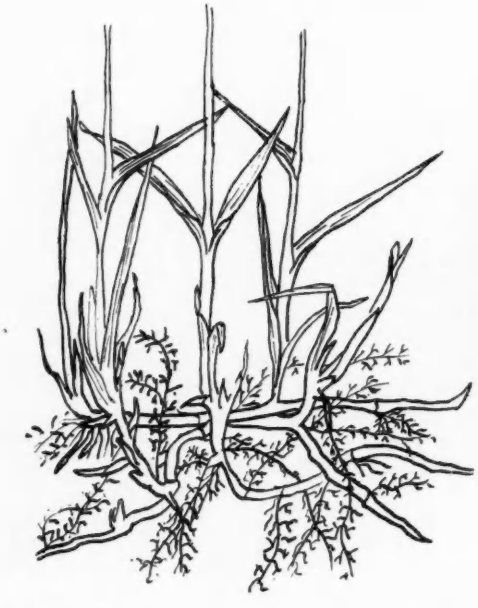
The recolonisation of estuaries by *Spartina* may arise from seed brought into the water-ballast tanks of ships, by birdlife feeding elsewhere, or portions of root. The early detection of first plants is easily obtained from local amateur botanists and wildfowlers, and eradication by simple digging out is then much easier.

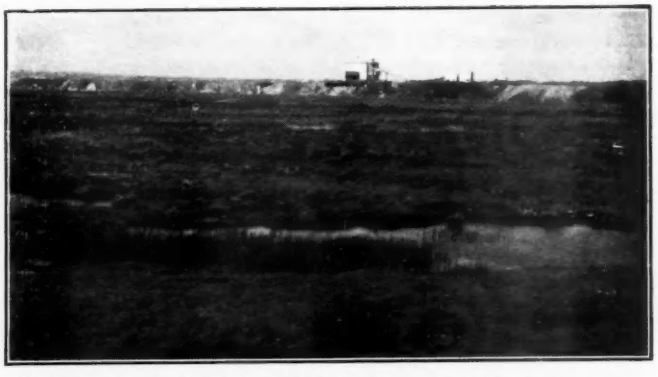
About fourteen species of *Spartina* grow mainly in the tidal marshes of temperate regions, but *S. townsendii* is the most important. It has been introduced as a mud-binder in many places, and elsewhere eradicated for its influence upon silting. Since this species arose from a hybrid between the European *maritima* and the American *alterniflora* in Southampton Water, it has been introduced to many parts of Western Europe, North and South America, New Zealand and Australia. *S. townsendii* exceeds the others in size by attaining a growth of 4-ft. It is jointed like the older kinds, but it does not break at the joints. Its grassy leaves stand out, broader at their bases, and its downy yellowish glumes or flower-heads are conspicuous in the latter months of the year.

Its generic name of *Spartina* means cord, from the strength of its roots. It rapidly colonises the soft, sticky tidal mud of shifting banks where no other vegetation grows, ranging from high water level down to a sea depth of about 6-ft. It thrives best between 2-ft. and 4-ft., and tolerates from two to three hours immersion by the sea. The lowest record is in 10-ft. of water, and its growth is much slower in deep water than in shallow. With five hours submergence by the tide it seldom grows more than 2-ft. high and rarely flowers. Its vegetative spread on soft mud will be at the rate of 1 to 2-ft. radius per year, but on firm, stabilised mud banks, only 6-in. radius.

Root formation is rapid after two-year-old seedlings are established, and unstable mud banks are fairly quickly checked. But there is a real danger of the creeping rhizomes or horizontal underground stems getting out of control. They grow just below the surface of the mud and bind it against erosion. In addition to surface roots which feed from the mud, deep anchorage roots go far down.

Growing under favourable conditions, a single *Spartina* seedling planted in its second year will grow 3-ft. in diameter in 18 months, and 12 to 15-ft. in diameter in three years. In fifteen to twenty years, a few scattered hummocks of seedlings become a continuous vegetational cover over acres of mud-bank. Poole Harbour in Dorset and the Vire Estuary in Normandy are classic examples of its colonisation in 17-18 years from a few natural arrivals in 1906. In the mouth of the Vire the growth reached 4 square miles in 17 years.





(Above) Part of the Dee Marshes on the Flintshire-Cheshire border where Spartina introduced on one side before the Second World War failed to spread much, but crossed to the opposit bank and has since greatly increased to accentuate silting of channels.
(Left) *Spartina Townsendii* or Cord Grass showing how the intertwined network of fibrous roots and creeping rhizomes of the plant hold firm and bind mud banks.

Such growth can, at its maximum, raise the level of mud-banks by 8-in. and stabilise soft banks sufficient for a man to walk over the roots. It is thus an advantage where reclaiming is desired, and a disadvantage where navigable waters for small craft are concerned. In 1928, a thousand plants from Poole Harbour were planted in pure sand in the Dee banks at Connah's Quay. About half survived, stabilising the bank, collecting silt, and later giving harbourage to other plants. Further plantings grew to 18-in. and seeded, but in recent years the plant tended eventually to die back. It has, however, increased rapidly on the opposite side of the river, perhaps from broken stems washed across on the tide, or drifted seed.

Excess growth can be checked by burning the tops in summer low-tides, but it is not practical to dredge or dig out the root-masses, fragments of which, when left behind, grow into fresh plants.

Mersey Docks and Harbour Board

Review of a Record Year for the Port of Liverpool

At a meeting held last month, Mr. M. Arnet Robinson, chairman of the Mersey Docks and Harbour Board, reviewed the operations of the Board during the year ended July 1st last, and reported new records in respect of traffic. He pointed out that, although during the year shipping was still facing difficult conditions, the port had experienced considerable buoyancy of traffic. The total tonnage of vessels entering and leaving the port, i.e., using Liverpool, Manchester, Garston or Bromborough, at 58½ million tons, and the portion of that tonnage using the works of the Board, at 39½ million, were both records. This latter figure was highly satisfactory in itself and reflected the steadiness with which shipowners have maintained regular services. The total revenue from dock rates and town dues on goods also showed a healthy increase during the year although, naturally, subject to the variations, both geographical and in particular commodities, which were inseparable from international trade. It was noteworthy when one looked at the figures of foreign outward tonnage which this year were nearly 4½ million tons, to observe the satisfactory upward trend maintained, again with variations due to particular international causes. The tonnage exported from the port had virtually doubled over the level of that which was ruling during the 30's. It was a matter of interest also that the tonnage of vessels entering and leaving the docks was a third higher than the tonnage of 1914. The cargoes (including petroleum) imported into Liverpool from abroad during the year showed an increase of nearly 25 per cent over 1914.

Major Step in Port's History

Tonnage in future years would be considerably influenced by the attraction of substantial oil traffic to the new Tranmere installation which had only just opened before completion of their financial year. In this scheme they had been partners with the Shell undertaking, the Board being responsible for the stages and approaches and the Shell Refining Company for the land side of the installation on their leasehold from the Board. In recent years there had been a notable development in specialised ships for the carriage of specific bulk commodities. The Board had sought to attract to the port such traffic and the terminals for bulk sugar and iron ore, as well as for the reception of oil, were instances of their determination to keep the port fully abreast of these changes.

Expenditure up to the 1st July last had not shown as steep an increase as in some previous years with the exception of their growing interest bill which was accounted for by the major capital programmes upon which they had been and, in fact, were still engaged, and also the increase in local rates due to the reduction from 75% to 50% in the statutory relief enjoyed by transport undertakings such as the Board. Since the 1st July, however, there had been certain major increases in wages granted under National Agreement, the effect of which upon the Board was very considerable, whilst the general atmosphere and negotiations now pending in various quarters all seemed to indicate that revenue expenditure was unlikely to fall. In saying that, Mr. Robinson knew that every effort had been and was being made to economise. Advantage was being taken of the introduction of mechanical methods and electronic computing but savings in these and in many other directions took time to make themselves felt. In any case, one could not envisage that these could offset the general rise in costs to which he had referred.

They were now beginning to see the conclusion of the Langton/Canada Scheme and it was hoped that in some 12 months' time the major part of the work would be complete. This would include some but not all of the new sheds which formed part of the scheme, the major part of the shed at West Canada having, of course, been operative for some time. As regards other shed construction, new sheds at South West Bidston and North Sandon were brought into commission during the year and they were well advanced with the major reconstruction of West Huskisson, the Northern portion being already operative, and also with East Toxteth. These developments would ultimately improve the berthing position, which had given rise to many problems, and would enable them to deal more readily with a great volume of traffic which interests of the most varied nature desire to bring to the port.

The Board had now received a Report from the Hydraulics Research Board at Wallingford following the investigation they made at their request into the conservancy regime of the river and channels. This raised questions of profound importance, to which close attention was now being given.

Problem of Finance

In conclusion, Mr. Robinson said, "Inevitably in our consideration of the wide range of problems affecting a great port such as this, one comes back to the problem of finance. I have, on more than one occasion, indicated that the level of the Board's dues could not be maintained indefinitely. We have not, in fact, altered the level of our general dues since the earlier part of 1957 and this, in the face of the pressure on costs, is no mean achievement. It will be our endeavour to hold off the question of an increase for as long as possible, bearing particularly in mind the balance carried forward on the 1st July, 1959, on our general account, of £434,00 to which must be added the balance on the current years' revenue account of some £76,000. The public may rest assured that the membership of this Board, representative as it is of payers of dues of all classes, will have very strict regard to all the factors involved in their consideration of our finances although it must be borne in mind that there are many uncertainties ahead for those responsible for the maintenance and development of major capital works. In the case of ports and especially a great tidal port such as Liverpool, much expenditure must be devoted to such works as docks and entrances, which are amongst the strongest and most enduring of man's labours and, therefore, take a considerable time to build or develop. One often feels in such matters balanced on a razor edge between too early a start with a consequent undue burden on the generation concerned or delaying too long with a hindrance to the next generation. Obviously such vital questions are much in our minds."

Increase in Trade

In a review of some of the more outstanding developments of the year ended July 1st, issued with the accounts, it is stated that the total quantity of cargo of all types, both foreign and coastwise, handled during the year was 17,502,383 tons compared with 16,566,772 tons during the previous corresponding period, an increase of 935,611 tons.

There were one of two significant changes in the general pattern of trade. The total foreign imports of food, drink and tobacco fell by 462,101 tons to 4,049,029 tons, largely due to reduced imports of animal feeding stuffs, grain and sugar. Raw material imports on the other hand, increased by 356,121 tons to a total of 3,457,835 tons due to greater quantities of iron ore, wood and timber being handled. Imports of manufactured goods also increased from 698,131 to 890,025 tons, mainly by reason of a large increase in the quantity of iron and steel arriving at the port.

Total exports at 4,427,893 tons showed an increase of 2.4 per cent, the principal commodities increase being in chemicals, soap and oils, sugar and molasses.

The Work of a Diver in Harbour Waters

By Captain W. O. SHELFORD, R.N. (Retd.)

Docks and harbours all over the world are virtually dependent on divers to maintain efficient operation. The port diver has many and varied assignments, but few people have much idea of his work or the conditions under which he carries it out. To start with the underwater port installations themselves must be constantly inspected and repaired where necessary. Timber piles may rot, steel ones rust, and fast running tides can wear away stonework and concrete—winter gales may cause a heavily loaded ship to be blown against a jetty and the whole structure may be dangerously weakened without showing any signs above water.

Pumping and power house inlets, and the sills of lock gates or caissons frequently need clearing of accumulated debris, whilst no ship can be docked down until the diver has been down to check the alignment of the blocks under her keel.

The ships themselves may have underwater damage which must be inspected before docking. Sometimes it is found to be of only minor character in which case the diver carries out the necessary repair and saves the cost and delay of docking. Mooring ropes can be badly handled and land up in an untidy heap of " knitting " round a moving propeller and once again the diver is called out to clear the mess.

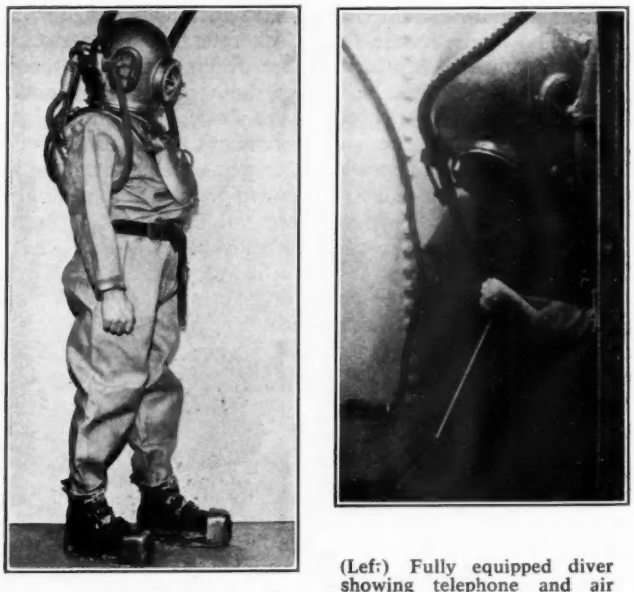
Many people cannot control their impatience while a diver is down and the accusation is all too commonly made that divers spin out jobs as long as they can to get more money. Nothing could be more unfair. Port divers in particular almost invariably have to work in most unsatisfactory conditions, and anyone who was to go down in a dock or harbour would realise that no one would stay down there longer than necessary. The water is almost invariably black and the diver has only his well-developed sense of touch to aid him in his work—lights are of little use in these conditions. If he has to work on the bottom, he is probably over his boots or deeper in thick black ooze, and surrounded by debris such as old wires and ropes which can become coiled round his legs or his gear—water that has been standing more or less unchanged in an enclosed dock for years will have a bitterly cold layer near the bottom, whilst in river berths there is always a current to contend with. Apart from all this a diver is a craftsman and has as much pride in carrying out his work efficiently and quickly as any of his fellow workers on the surface.

The equipment most used in harbour work is still the traditional heavy gear with its familiar round copper helmet, rubberised dress, heavy weights front and back and weighted boots. Nowadays it is more likely to be supplied with air from a motor-driven compressor or from a shore air-line, rather than from the hand-pump with its big cast-iron flywheels. This gear still has many advantages over the currently fashionable "Aqualung" or self-contained compressed air apparatus. Most important of all is perhaps the protection it gives the diver against cold, against injury from jagged edges of steel, barnacles or more active forms of marine life. His head is well protected when working in the dark under a ship's bottom or among a labyrinth of jetty piling. Within the physiological limits imposed by working under pressures, the diver can stay down as long as the compressor can run or the pump be turned. The eighteen pound lead boots give him a good steady " platform " on which to anchor himself when doing work like welding or cutting under water. Above all the " standard " gear is the only type as yet for which efficient telephone communication has been developed using loud speakers both in the helmet and on the surface.

The " Aqualung " compressed air equipment is, however, being increasingly used. Naturally it finds favour overseas in hot climates, because it can be worn with light rubber suits or for that matter with no suit at all. One of the great disadvantages of the standard gear is heat. The diver in the tropics is soaked with sweat before he has finished dressing and he gets little relief under water, because the compressor is probably running too hot to touch. Refrigerated compressors are available but they are large and complicated and will not fit into the normal boat used for diving.

The Aqualung or Frogman diver is, of course, more mobile, not only under water but on land as well, because his complete outfit can be packed into the boot of an ordinary car and can be easily carried by a couple of men. He is, however, severely limited by the capacity of his air cylinders and once they are empty he has no choice but to come out. Then there must either be spare cylinders available or a compressor capable of producing clean respirable air at 1,800 p.s.i., or more.

The Aqualung therefore commends itself mainly for survey work or quick emergency jobs, but the standard gear remains as the diver's working kit.



(Left) Fully equipped diver showing telephone and air hose. (Right) Diver with under-water welding torch.

A possible compromise which is gaining popularity is the " Surface Demand " or " Hookah " equipment. In this the air supply, which can be from one or more large storage cylinders feeding through a reducer, or from a compressor, stays on the surface and all the diver wears is the " demand valve " on a simple harness. This valve is connected to the surface air supply by means of a small diameter hose, more flexible than the standard diver's but equally robust. The diver therefore has virtually no limit on endurance, and is reasonably mobile as long as he looks after his hose. Again he need only wear a light-weight suit, or none at all, but he is, of course, as vulnerable to injury as the frogman.

Neither the frogman nor the hookah diver need wear heavy lead weights. Unlike the standard diver the suit (when worn) is not inflated but collapses on the body giving minimum buoyancy. If the water is cold and woollens are worn under the frogman suit, air will be trapped in the under clothing, so a quick release belt with perhaps 20 lbs. of lead is worn to counteract it. This is one-sixth of the weight worn by the standard diver who breathes from inside his suit which in consequence must be kept partially inflated. The big helmet, heavy enough on land, is of course very buoyant under water so that the whole rig carries a total of 120 lbs. of lead.

As is well known the design of the standard gear used by the

"deep-sea" diver has changed very little over the years, but there has been considerable advance during and since World War II, in the tools and accessories available to the diver to help him carry out his work.

First and most important of these is the technique of underwater cutting. There are two types, oxy-hydrogen and oxy-arc, each of which has its own special advantages. Oxy-hydrogen is limited in depth to about 100-ft. but can cut through steel up to 4-in. thickness; oxy-arc on the other hand can be used much deeper—it has actually been used on a major operation in 220-ft. but is limited to cutting through plate of $\frac{5}{8}$-in. thickness approximately. It also has the advantage that it can be used with standard arc-welding generators which may already be available on site, so that it is generally more portable than oxy-hydrogen for which considerable quantities of both gases must be available in any large operation.

Oxy-hydrogen gas mixtures are used because acetylene is only suitable for use in very shallow depths, otherwise the principle is similar to oxy-acteylene gas cutting. To enable the flame to burn under water a hood is fitted over the nozzle which serves to trap the expanding gases which are the result of combustion and thus form a shroud in which the flame can burn. To assist this process, and for initial lighting compressed air or oxygen is fed into the annular passage between the nozzle and the hood.

In oxy-arc cutting, a special electrode holder with a hollow electrode is used; the metal is heated first by the arc, then oxygen is injected down the centre of the electrode causing the metal to burn away instead of melting.

Arc welding under water is another technique that has been perfected since the last war. The technique is very similar to surface welding; the diver wears rubber gloves and the front "eye" of his helmet is fitted with a hinged coloured glass. The electrodes are insulated and the holder must also be carefully insulated to prevent leakages and electrolysis. Due to the conditions under which the diver has to work his speed of welding will be slower than his surface counterpart and of course the same quality of work must not be expected. Underwater welding is most useful for repairing steel structures permanently under water, but is rarely used for ship repairs except in emergency.

Another useful emergency tool is the Cox's Submerged Bolt-driving and Punching Gun. This is an impulse operated tool which can drive threaded steel bolts into steel plate up to 1-in. thickness or can punch holes in plates up to $\frac{3}{4}$-in. thick. There are two sizes of gun; No. 1, the lighter of the two can drive $\frac{1}{2}$-in. B.S.F. $3\frac{1}{4}$-in. long screw bolts into plate up to $\frac{5}{8}$-in. thick and punches holes $\frac{5}{8}$-in. dia. into $\frac{1}{2}$-in. plate. The No. 2 gun which is in most common use drives $\frac{5}{8}$-in. B.S.F. $4\frac{1}{2}$-in. long screw bolts into plate up to 1-in. thick and punches 11/16-in. holes in $\frac{3}{4}$-in. plate. The tensile strengths of the two types of bolt are 10 and 16 tons respectively, while the pressure required to drive the No. 1 bolt out of $\frac{5}{8}$-in. plate is 8 tons, and the No. 2 Bolt out of $\frac{3}{4}$-in. plate, 12 tons.

The gun is simple and safe to use and fires without flash or recoil. Detachable barrels, of different lengths to suit particular usages, are loaded on the surface and passed down to the diver. All he has to do is to clip in a loaded barrel, position the gun, fire the bolt and then change barrels for the next shot. It will be seen that this tool is ideal for putting temporary patches on ships or underwater structures since it obviates the need for marking off, drilling and tapping. It can also be used with a special hollow bolt to which a standard diver's air pipe can be connected for de-watering a flooded compartment or similar work.

Pneumatic tools also form part of the diver's armoury but these are usually of standard design with the addition of an exhaust air collector so that the exhaust air can be led back to the surface. If this is not done it is necessary to increase the pressure of air delivered from the surface by an amount equal to the water-pressure at the depth of operations. In anything but very shallow water such pressures may be beyond the safe working pressure of the compressor and air hoses. Piping away the exhaust also prevents the diver being blinded by its bubbles.

Diver using Cox Bolt Gun under water.

It has already been mentioned that lights are of little use in dock and harbour conditions, and this is certainly true of the normal filament floodlights which only serve to illuminate the particles in suspension in the water and throw the reflection back in the diver's eyes. It is in fact similar to driving a car in fog with the headlights up full.

Some improvement can be made in underwater visibility by the use of sodium vapour and mercury arc lamps. Their efficacy is dependent on the water conditions, its colour and the nature of the matter in suspension. The mercury arc lamp has a concentrated beam which can be used to spot-light a particular job at a range of two or three feet when the diver is trying to "see through mud."

Diver with T.V. Camera and lighting unit to aid diver with cutting apparatus.

Another device which has been tried in very dirty water is fitted to the front glass of the helmet, a cone of perspex about 6-in. long and the same in diameter at its outer end. The diver can press the front of this cone against the object he wants to examine at a distance at which he can focus his eyes in reasonable comfort. This was used with some success during the extensive salvage operations of the liner Empress of Canada which burnt out and capsized in dock at Liverpool.

The last and most modern aid to the diver is underwater television. Originally used to examine the wreck of H.M. submarine "Affray," which disappeared in mysterious circumstances in the English Channel in 1951, underwater television has been considerably developed in recent years. It is generally made in two principal forms; the deep sea version capable of use far deeper than any diver can go, and a smaller "diver held" version. The former is very costly and of little use for harbour work.

Diver engaged in Oxy-hydrogen cutting.

It employs the "Image Orthocon" tube, commonly used in studio cameras and has a complicated array of remote control adjustments. The latter, however, is of greater interest for inshore work.

Using the smaller and less sensitive "Vidicon" tube it nevertheless gives an adequate picture and tests have shown that it has greater penetration of dirty water than the human eye. The casing is constructed to go to deep depths if necessary but is intended primarily to be manœuvred by a diver to instructions telephoned from the surface. It can be fitted with its own lights and can contain the telephone transceiver so that the diver need not necessarily wear a phone. The whole unit is designed to be "neutrally buoyant' so that it can be handled by a frogman.

It is intended that, during inspection work the diver will manœuvre the television camera as directed by the surface "spectators," either to get on to the correct target or to move to another area for examination. On the surface, in theory at least, interested people can see the objective themselves on the monitor screen and can even photograph the screen. Thus, it is claimed one is no longer dependent on the intelligence or otherwise of the diver, and one will not have to base operations on such reports as, "There's a blooming great 'ole down there."

On the other hand the cost of the outfit is approximately equal to the salary which ought to be paid to a really experienced and capable diver and it is a debatable point in which direction the outlay will produce the best dividend in the long run.

This is the general picture to date of the modern harbour diver and his equipment. Readers who have watched the fantastic underwater feats of television divers may feel faintly disappointed that more dramatic developments have not been described, but it must be remembered that it is one thing to stage a television show in clear water and quite another story altogether to go down and carry out a job in the conditions "as found." Whilst research into possible improvements in diving gear never ceases, enthusiasm for some new gadget frequently gets a cold douche from the need for commercial efficiency. Dock and harbour work would of course provide a great testing ground for new apparatus, but a great many much publicised "diving" equipments would regrettably be found wanting in this hard school, with financially disastrous results.

Recent Metallurgical Developments

By L. SANDERSON

High strength, low-alloy steels have for a long time been adopted for constructing bridges, and many modern designs could not economically have been carried out without them. This is because the specifications called for strengths that in carbon steel meant excessively heavy sections. It has now been shown conclusively that low alloy steels containing nickel and copper in the form of alloys are more resistant to corrosion than carbon steels; the paint coatings adhere more firmly; have a service life from 20 to 80 per cent longer than that of carbon steel; and are extremely resistant to corrosion-creep, i.e. the accelerated failure of the paint film as a result of local damage. The enhanced resistance to corrosion of these materials means a great reduction in maintenance cost and the cost of preventing corrosion, which costs can ultimately amount to nearly double the original construction cost of the bridge.

Another interesting development is the use of chromium nickel stainless steel in dredging. When the drag arms of a hopper dredger are scuttling along a harbour bed at a depth of 50-ft., precision control and a good deal of manœuvrability are needed. To provide these, two controllable pitch propellers have recently been installed in a hopper dredger in America. The controllable pitch wheels are made of 18 per cent chromium nickel stainless steel, which has a tensile strength of 31 to 36 tons/sq. in., yield strength of 16 tons/sq. in. minimum, and elongation of 45 to 50 per cent in 2-in. The impact resistance is double that of bronze.

This steel so used virtually eliminates carbide precipitation, resists the attack of salt water and cavitation erosion, and has the strength and toughness to deal with dredging operations. The propellers are 10.5-ft. in dia., the hub having a dia. of 34-in. The propeller control system is pneumatic and hydraulic, and pitch changing time is from full ahead to full astern in 11 seconds.

High strength alloys of aluminium are going into bridges and similar constructions. New techniques of coating them with enamel and plastics have been developed, and as heavier gauge

aluminium plate becomes available at a competitive price, other uses for these alloys will be found.

Research workers have discovered a means of hardening steel and other metals without impairing their ductility, toughness or flexibility. A metal normally embrittles after being hardened by heat treatment. In a new process known as "Thermomagnadynamics," heat-treatment actually modifies the grain structure of the metal so that it maintains its strength under stress. It is hoped to supply alloys shortly that are still ductile when hardened to resist a high tensile stress.

Materials of construction for tools such as rivet sets, pneumatic chisels and machine screwdrivers, subjected to dynamic loads, have been improved by the use of a chromium nickel molybdenum tungsten steel, the composition of which is as follows: 0.65 to 0.85 per cent carbon, 0.5 to 2.5 per cent silicon, 1.2 to 2.5 per cent chromium, 0.3 to 1 per cent nickel, with possibly 0.2 to 1 per cent tungsten and/or 0.1 to 0.6 per cent vanadium. Tests with pneumatic cold chisels are said to have shown that life was at least 25 per cent longer than those made from the previously used steels, an increase attributed to the higher compressional strength of the latter materials.

In various lifting trucks doing rugged lifting and hauling in docks and harbours, a revolutionary development may soon result if tests now going on in America with a new fuel cell prove successful. In this new cell, zinc replaces hydrogen in the fuel mixture of hydrogen and oxygen. This is believed to simplify the fuel cell and solve one of its most annoying problems, the generation of water as a by-product, which dilutes the electrolyte. The new cell has zinc oxide as a by-product.

The new zinc oxygen cell lasts much longer than a battery. After 18 to 24 hours heavy use, it can be recharged or its zinc electrodes can be replaced, at a cost largely covered by the market value of the recovered zinc oxide. The power potential is said to be greater than that of other fuel cells. The cell works at almost normal temperatures, yields no waste products needing to be removed, and can be of almost any size, while at the same time it can be mass produced. It is believed that if the tests go well, these new fuel cell operated trucks will be available in three years.

Aluminium is the basic metal in a new transport van which has been designed to make more efficient use of space and lower the cost of handling the goods contained. It has a whole side of doors that not only open wide, but also come right off together with the side sections between them. When the doors are swung back, the containers can be lifted in or out by fork-lift trucks. With the doors and side sections removed, the 10.2 metre long van is able to transport big cargoes such as large pieces of machinery and equipment. The vans cost about a third as much as ordinary ones.

A pneumatically-powered, electronically-controlled machine has been developed for the handling of bulky merchandise at a rapid rate and with complete safety. It is particularly suitable for lumber bundling. The bander employs tape of widths from about 1 to 2½ cm. and can tape objects from 5 to 30 cm. in height and width and any length of 30 cm. or more. The rate of handling depends on the size of the object handled and the number of wraps per piece. The maximum rate of application is six per minute. Similar machines can be obtained to meet other banding requirements.

Anti-Corrosion Measures

Up and down many coastlines, the ocean brings cool, moist air heavily laden with salt, which inevitably corrupts and corrodes much of the dock and harbour architecture and construction. For this reason 16 per cent chromium, 12 per cent nickel stainless steel is being increasingly used for a variety of exterior and interior details of dock and harbour buildings. In one instance, a two-storey main façade contains a large expanse of glass doors and window frames in this steel and is capable of withstanding the corrosive attack of the brackish air. On the opposite or beach side of the building, in a second entrance window unit and on a main staircase, nickel stainless steel has also been used to ensure a gleaming appearance that will last indefinitely without much maintenance. Many of the fixtures inside have also been constructed of stainless steel to resist corrosive attack by salt and fresh water and to reduce maintenance to a minimum.

Because experience has demonstrated the importance of visually inspecting fluid pipelines, sight flow indicators are finding employment on an increasing scale. The materials employed for these instruments are governed by the amount of corrosion resistance required. Nickel alloys are being increasingly used, and many indicators are now made from nickel bronze, nickel chromium cast alloy iron, chromium nickel stainless steel, high nickel copper alloys or pure nickel. The choice of metal is made by the user, and in the main the same metal as is used for the piping system is specified for the sight flow indicators.

Measures Against Fire Hazards

One of the dangers inherent in all repair and other activities around harbours and docks is the possibility that the working parts of tools such as shovels, spades, etc., may create a spark that will cause an explosion in an inflammable or explosive environment. Of recent date a means of preventing this has been patented. The implements concerned are coated with a deposit of non-sparkling metal by brazing or welding. The basis metal may be a steel or a non-sparking material such beryllium copper. The non-sparking coating is preferably an aluminium bronze containing 8.5 to 10.5 per cent aluminium, 3 to 5.5 per cent nickel, 3 to 5.5 per cent iron, 3 per cent max. manganese, 0.5 per cent max. zinc, 0.3 per cent max. impurities, and a balance of copper.

The Russians are using electropolishing to finish their metal cutting tools. The process is claimed to give close control over metal removal. It eliminates the surface skin of deformed metal without etching. Metallurgists and engineers are combining to consider the future design of appliances to be used in the mechanical handling of transportable commodities. The trends to be anticipated are smaller truck cases, higher lifts, and attachments that duplicate the movements of the human arm.

Liquid plastic applied to hot metals by a new process has the advantage that it does not crack or chip during application. The coating can be accurately applied in a wide range of thicknesses and is corrosion resistant. One interesting application is to the painting of long pipes, both inside and outside. A South African scientist developed the technique, and a big group is developing its use throughout the world.

Makers of heavy duty construction equipment, such as draglines and dredging appliances, are increasingly turning to a special type of tubing which begins as a single strip of copper-coated steel. This is continuously rolled twice about a tube of uniform thickness, the winding being lateral, and is then passed through a furnace which causes the copper coating to fuse with the steel. The result is a tube double-walled and brazed through 360 deg. at wall contact. The tubing is obtainable in sizes up to ⅝-in. outside dia. It is said to have high thermal conductivity, high bursting point, and high endurance limit. In addition, it is extra strong, ductile, light in weight, easily machinable and resistant to shock. It will accept a plastic coating or a plating, and has no internal beading. Both internal and external diameters are uniform.

Future Developments

Two developments of potential rather than immediate importance are the following. A number of organizations are trying to perfect a composite material combining ceramic fibres with metals so as to give a structure much stronger than the base metal itself. Materials so produced are intended to withstand erosion, high temperature, and radiation. In some combinations considerable reduction in weight is achieved. In one example, a cast material composed of 50 per cent fibre and 50 per cent metal had a weight for identical mass much lower than that of an all metal structure.

The second development is a research project aimed at finding a means of predicting the machinability of a metal by means of a study of its mechanical, thermal and metallurgical properties. If this is successful, it may be possible to produce scales or equations for accurate prediction of the machinability of newer materials and so cut the expensive preliminary trial and error.

High strength steels for bridges and other constructional work were first developed in the middle-thirties. During the last year or so there has been considerable development of a steel of this type to which the element columbium (sometimes known as niobium) is added. This addition is claimed to have increased the yield strength of a steel containing 0.15 per cent carbon and 0.5 to 1.5 per cent manganese from 15 tons/sq. in. to over 27 ton sq./in. Even though the steels are not fully hardenable, hea treatment greatly improves their properties, despite the sligh decline in hardenability that an addition of up to 0.07 per cen columbium occasions. One of the important aspects of thes steels is that weldability is increased. The materials are rathe more expensive, but if a correctly designed section is used, th saving in weight justifies the expense.

Still on the subject of high strength constructional steels, it is worthy of note that by rolling steel at 540 deg. C. in th austenitic state it has been found possible to achieve tensile strengths of over 178 tons/sq. in., with occasionally much higher results, so that eventually it may be possible to produce a considerably higher ratio of strength to weight.

High austenitic manganese steel, such as is used for dredger buckets, pins, links, bushes, and many other purposes where resistance to abrasive wear is encountered, is still being extensively used. Chromium additions to this steel have been found to improve yield strength and resistance to flow, while the addition of molybdenum tends to increase yield strength and reduce embrittlement. A development is in progress on lower alloy austenitic type steels which promise to combine toughness with improved wear resistance.

A Dismantable Bucket Dredger

High Output Achieved Dredging Guinea Canal

By Mr. L. d'HAILLE
(Director of the Dredging Section, Société Nationale de Travaux Publics, Paris).

In 1955 proposals were invited for the execution of a drainage project necessary for the creation of rice-fields in Guinea.

The work consisted of dredging a canal and reprofiling the upper course of the river Kapachez, which is subjected to tides and the bed of which was partially silted up.

The type of work and particularly the geographical nature of the working area, which is marshy region locally flooded at each high tide, and entirely inundated by 3-ft. of water about four months of the year during the rainy season, led to the choice of a floating craft.

The necessity of dredging a definite profile in soft slightly clayish mud, and of forming dikes alongside the canal by means of the dredged soil, which should be as dry as possible in order to maintain the profile of the dike and to avoid flooding of the surrounding cultures, made the Société Nationale des Travaux Publics abandon their initial intention of acquiring a suction dredger, and after having thoroughly studied the design problems in close co-operation with I.H.C. Holland they decided to order a bucket dredger.

General view of the dredger at work.

Dredging a canal through virgin territory.

The profile of the canal and the necessity of depositing the dredged spoil at a distance of more than 40m. (130-ft.), did not allow the use of long chutes, which might have endangered the stability of the dredger, the breadth and draft of which were strictly limited.

The solution adopted was a small bucket dredger provided with a primary conveyor depositing the spoil into a hopper fitted on an auxiliary pontoon and feeding a secondary conveyor which would deliver the spoil to the banks.

The contract stipulated a volume of 500,000 m^3 (650,000 cu. yds.) of soil to be dredged and to be deposited on the banks within twelve months. Consequently, despite its small dimensions the dredger had to be capable of ensuring a continuous high output and hence it was equipped with buckets having a capacity of 220 l. (7 cu. ft.) and a shape adapted to the soil, by which an output of 200 m^3/h (7,000 cu. ft./h) would be possible.

A diesel engine developing 170 h.p. drives a generator and an alternator fixed to the shaft end. The generator supplies direct current for the motor of the bucket chain, the alternator feeds the winch motors and the conveyors. Fully equipped, the dredger measuring 35 x 7 m. (90 x 23-ft.) has a draft of 1.05 m. (3-ft. 6-in.). The auxiliary pontoon of 14 x 10 m. (40 x 33-ft.), equipped with a conveyor of 40 m. (130-ft.) and a counterweight, has a draft of 1 m. (3-ft. 3-in.).

A Dismantable Bucket Dredger—continued

The forward movement of the dredger is effected by means of spuds. The small dimensions of the canal: 15 m. (50-ft.) at bottom depth and 30 m. (100-ft.) at water level, and the obstruction caused by the primary conveyor, made it necessary to provide the two spuds in the middle of the dredger. The lifting masts of these spuds were placed on top of the main gantry. The guiding tube of each of the two spuds is fitted in a drum which can rotate in a cylindrical well, fitted in the hull of the dredger. These drums are self-floating.

The eccentric position of the guiding tubes permits of shifting the two spuds by turning the drums in their wells. Thus the width of the cut and the forward movement of the dredger at each swing can be regulated.

All movements of the dredger are effected by means of a central winch having six drums for the two swing wires forward, the two hauling wires and the two spud hoisting wires.

In order to be able to operate the dredger with a minimum of labour, all controls are centralised in the dredge-master's cabin.

Push buttons and rheostats fitted on a control desk, permit of regulating the speed of the different motors: dredging, hoisting of ladder, winches and conveyors.

By means of mechanical control the movements of the dredger shifting of the spuds and the swinging movement can be regulated.

The particularly difficult access to the working area raised problems for the transport of the dredger. It was therefore designed for shipment in dismantled condition as deck cargo on board a vessel and the weight of each lift was to be a maximum of 50 ton. The hull of the dredger was constructed in two sections, each provided with partial bulkheads to be able to reassemble the sections while floating. All installations; pipelines, electric plant, etc. were fitted in either of the two sections of the hull, so that after assembly the connections could be easily effected.

The order was entrusted to I.H.C. Holland in April 1955 and towards the end of the year the dredger was already undergoing its trials in Holland. It was then dismantled and shipped to Conakry, where it arrived in February 1956. After unloading partial reassembly took place within twenty-four days. The assembly of the two hull sections took only nine hours.

The first belt conveyor.

The second belt conveyor.

The dredger was then towed to the working area, located on the coast about 160 km. (100 miles) north of Conakry, where the assembly was finally completed. In this isolated and marshy region, where neither roads nor tracks gave access by vehicle to the vicinity of the canal, the erection of the supporting legs of the conveyors and of the bucket chain had to be done with the means available on board. The problem was solved by installing a heavy crane forward on the dredger and by using the lifting masts of the spuds as derricks.

Again in view of the isolated working area, the builders were asked to provide accommodation on the pontoon for the crew, containing bedrooms, galley, and toilet facilities, and in addition a small workshop with lathe, boring and grinding machine and electric welding apparatus, in order to ensure the execution of current maintenance work by the crew on board.

The dredger started work in April 1956 and since then it has dredged within fourteen months a canal 7 km. (4 miles) long, removing about 565,000 m³ (750,000 cu. yds.) of material. Another identical dredger was ordered by the Société Nationale des Travaux Publics for the execution of similar work on the Island of Madagascar.

Port of Liverpool Retirements

At a recent meeting of the Mersey Docks and Harbour Board the retirement was announced of **Mr. J. D. J. Saner,** M.C., M.I.C.E., Engineer-in-Chief of the Board. During his service of over 36 years with the Port of Liverpool, he has been intimately associated with the many and varied engineering projects undertaken by the Board and assumed full responsibility for these works when he was appointed Engineer-in-Chief on the death of Mr. Porter in 1958.

Mr. Saner's responsibilities have been considerable for they have embraced some of the most diverse engineering undertakings carried out by any Port in the World during the post-war years. As a consequence, he has had to cope with problems covering every facet of his profession—civil, mechanical, electrical and marine, as well as the extremely complicated task of maintaining the river and sea approaches.

At the same meeting, the retirement was announced of **Mr. Alma Parkin** who was elected a Member of the Board in 1934. He has served on several of the Standing Committees, and was Chairman of the Works Committee from 1948 to 1958.

As already reported **Mr. N. A. Matheson,** M.I.C.E. is Mr. Saner's successor as Engineer-in-Chief and **Mr. S. J. Gearing,** B.Sc.(Eng.), M.I.C.E., has been appointed Principal Assistant to the Engineer-in-Chief.

Revised British Standards

Pallets for materials handling for through transit (B.S.2629: 1960). Obtainable from the British Standards Institution, 2 Park Street, London, W.1. Price 6s.

This British Standard was first published in 1955 to establish a series of pallet sizes and capacities for through transit which were acceptable to transport organisations and convenient for transport and storage within individual organisations. The aim was to ensure that palletised unit loads could be moved from manufacturer to consumer with the minimum of handling and by means of as wide a range as possible of handling equipment. It has now been revised and the new edition gives full recognition to the work on palletisation carried out by the International Organisation for Standardisation (ISO).

The three sizes of small flat pallets considered by ISO to be suitable for international trade have been adopted as British Standard sizes, namely: the 32 x 40-in., 32 x 48-in. and 40 x 48-in. Two other sizes of flat pallets have been included: the 40 x 40-in., which is considered one of the most suitable sizes for transport in standard railway vehicles in the United Kingdom, and the 36 x 48-in., which has been introduced at the request of the refractory products industry and the steel industry. All five sizes have been adopted as the British Standard sizes for box pallets and post pallets.

Another change in the standard is the adoption of the ISO recommendation for the minimum size of opening in the bottom deck of pallets provided for handling by pallet trucks. This change will not materially affect the various types of pallet trucks in use today. The standard also includes a list of terms and definitions which have been established internationally by ISO and which will be the subject of a future ISO recommendation.

Connectors for timber (B.S.1579: 1960). Price 6s.

To take account of the types and sizes of connectors now generally available in this country, this British Standard (first published in 1949 and revised in 1953) has again been revised under the authority of the Timber Industry Standards Committee.

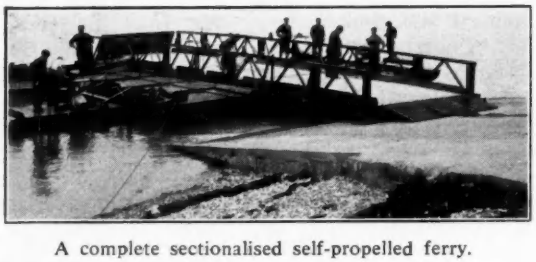
The principal changes in the specification are the reinstatement of the malleable cast-iron shear-plate connectors, the elimination of corrugated toothed-ring connectors and a modification of the shape of the teeth in the round toothed-plate connectors.

To reduce the possibility of confusion resulting from reference to connectors by table numbers, each type of connector has been alloted a number and the size and sub-type are indicated by a suffix. A list of connector numbers is given in an appendix. Dimensions and materials of the connectors are covered, but data on the strength properties of joints made with the connectors are not included. British Standard Code of Practice, C.P.112, "The structural use of timber in buildings," contains such data relating to those connectors which are in accordance with this standard and on which authenticated tests have been carried out.

Manufacturers' Announcements

Light Alloy Sectionalised Ferries

In many of the under-developed countries, the means for crossing rivers are either non existent or of a primitive nature, unsuitable for modern heavy transport. In regions such as these, where geographical and other conditions make the building of permanent structures impracticable, there is often a need for equipment which can transport vehicles and personnel across the water, but which may not be permanently required in one location. One answer to this problem is the provision of ferries which can not only be rapidly constructed and dismantled, often under adverse conditions and with a minimum of trained labour, but which can also be "broken down" into units which can easily be transported from point to point by standard vehicles. Saro (Anglesey) Limited have recently supplied to the Crown Agents, acting on behalf of the Government of Ghana, equipment which can be made up into either a ferry capable of carrying a load of over 25 tons, or



A complete sectionalised self-propelled ferry.

alternatively into two ferries each with a carrying capacity of approximately 10 tons.

The basic unit from which these sectionalised self propelled ferries are constructed is the aluminium alloy pontoon which is of riveted construction, 17 ft. 6 in. long by 5 ft. 9 in. wide and is fabricated from aluminium alloys specially chosen for their high resistance to corrosion. Each pontoon is divided into a number of water tight compartments and the deck of the pontoon carries fittings for securing the superstructure, roadway section and ferrying accessories both during transport and when the pontoon is in use.

A complete ferry, capable of carrying a load of 10 tons, is composed of eight such pontoons, and it can be transported, together with all ancillary equipment by three standard three ton capacity lorries and two special trailers. Construction is both simple and rapid, and can be carried out with little training by a small body of men in under an hour.

Although lifting tackle is desirable for the off-loading of the pontoons from the vehicles, for the construction of the ferry itself the provision of cranes, tractors and trailers, is not essential, as all the components are light weight and so make man handling a practicable proposition. In addition, all the units have extremely comprehensive and accurate jigging and gauging which ensures that there is complete interchangeability of the units throughout the life of the equipment.

Basically, the erection sequence is a follows :

The pontoons, preassembled into units, with their associated equipment, are off loaded from their lorries and trailers at a suitable marshalling area. At this stage, the steel girder panels and their supporting rakers which are carried on the pontoons and which are used to strengthen the complete ferry and to distribute evenly the heavy loads imposed upon it, are erected. Pairs of pontoons are then coupled together stern to stern and either transported by the special trailers provided, or sledged to the river bank where they are launched. As each pair of pontoons is launched it is brought to the bank where it is coupled to the previous pair until a raft of four pairs of pontoons is formed. Aluminium decking sections fitted to each pontoon give an overall vehicle roadway width of 11 ft. Vehicle loading and off loading bays composed of further roadway sections, girder panels and ramps are now added to each side of the ferry. These can be lowered or raised by special equipment to allow vehicles on and off the ferry, and to compensate for any tidal or other changes in water level while the ferry is at the bank.

Additional equipment carried includes hand winches, anchors and cable for holding the ferry against the bank or in mid stream and hand bilge pumps.

Finally, the two outboard power sponsons, which have been specially designed for use with the ferry, are attached to the bow of the pontoon, one to each side of the ferry. These consist of a simple form of pontoon structure, with a centrally located rotating ring into which is fitted the outboard motor. The ring can be

rotated through 360° to provide complete directional control.

During the course of speed and manoeuvring trials carried out recently on the exposed waters of the Menai Straits, the ferry was used to transport a 25 ft. 6 in. wheelbase vehicle with a total laden weight of 15 short tons, the ferry being powered by two 18 h.p. British Anzani outboard motors.

A ferry of this type is capable of taking considerable punishment as many of the buoyancy compartments on any one pontoon have to be damaged before a unit needs replacement. In addition, the aluminium alloys have great flexibility and resilience and the corrosion, maintenance, painting and handling problems are negligible compared with those of the conventional ferries.

The construction of a ferry capable of carrying loads of over 25 tons is achieved simply by attaching a further three pairs of pontoons and associated equipment to the smaller capacity ferry.

Workboat for Government of Ethiopia

The launch "Ababa Assab" recently supplied by Universal Shipyards (Solent) Ltd. to the Government of Ethiopia will be used for general harbour duties, including light towage and the laying of moorings. The vessel, with a length O.A. of 25 ft. and a beam of 8½ ft., has been designed to provide a robust yet low priced workboat suitable for almost all harbour duties, and particular attention has been paid to ease of repair and maintenance by making the structure as simple and clean as possible.

Welding is used throughout and the tubular steel gunwales, stern and keel besides adding to the attractive appearance of the vessel, are very strong. Two watertight peak bulkheads are fitted together with three deep 'T' section frames, the engine bearers are fabricated but, other than the keel and gunwales, no longitudinal framing is employed.

The "Ababa Assab" is powered by a Perkins Four/270(D) marine diesel engine fitted with a 2 : 1 Self-changing Gears Ltd. oil-operated reverse reduction gear and developing 58 b.h.p. at 2,000 r.p.m. Cooling is by an integral freshwater heat exchanger unit. Steering is by wheel operating through a Whitlock marine gearbox in conjunction with rods and levers. The rudder, which has a contra-flow leading edge, is carried on two water lubricated bearings.

A midship towing post is fitted and on trials at ¾ throttle a bollard pull of 10 cwt. was registered. The speed of the vessel unladen is 8½ knots at 2,000 r.p.m

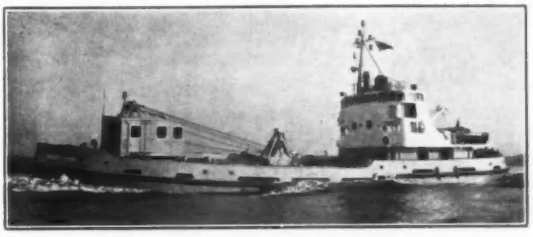
Dredger for King's Lynn

A new diesel grab hopper dredger with a length O.A. of 138 ft. 4 in., moulded breadth of 32 ft., moulded depth of 10 ft. 9 in. and a hopper capacity of 350 cu. yds., was recently handed over to the British Transport Commission after successful trials on the River Humber.

Built by Richard Dunston, Ltd., at their Hessle Shipyard, the vessel has heavy scantlings, a raked soft nose stem, cruiser stern with the machinery aft. The hopper well is arranged amidships and a diesel grabbing crane on the fore deck is capable of dredging directly over the bow.

The hopper of welded construction is fitted with 10 bottom doors controlled by two Vickers-Armstrong hydraulic rams arranged P and S at the fore end of the main deck. The rams are connected to the doors by chains and sliding bars. The grabbing crane, supplied by Priestmans of Hull, has a 62/50 cu. ft. capacity mud grab bucket and is capable of operating at a radius of 20 ft./30 ft. max. and a dredging depth of 50 ft. below water level. An underwater eye consisting of two dials indicates the operating depth and the position of the crane superstructure thus enabling the driver to operate blind. The cab is electrically heated and connected to the wheelhouse by telephone. When on salvage or buoy duties, two steel struts can be fitted to the crane jib-head to increase the lifting capacity up to 20 tons.

The propelling machinery consists of a "Mirrlees" diesel engine



The new diesel grab hopper dredger.

with a continuous rating of 800 b.h.p. at 700 r.p.m. and coupled to a Modern Wheel Drive 3½ : 1 reverse reduction gearbox. The engine and gearbox are fitted with "Chadburn" remote controls. A total generating capacity of 120 k.w. is installed and comprises two 50 k.w. 220 v. D.C. generators each driven by a 100 b.h.p. diesel for use when in harbour. All generators are suitable for running in parallel. Except for a diesel driven air compressor, all other auxiliary machinery is electrically driven.

Towing Launches for Tasmania

Two towing launches were completed recently at the Singapore yard of John I. Thornycroft & Co. Ltd. for service in Tasmania, and will be used in connection with the construction of the new ¾-mile "Tasman Bridge" across the Derwent River at Hobart. They are required mainly for towing barges transporting building materials of loads of up to 50 tons, but, when required, they can each carry up to 20 persons.

The dimensions of the launches are 29-ft. in length, 9-ft in moulded breadth and with a draught of approximately 3-ft. 3-in. The hull is of round bilge form, carvel built in single skin teak, on steamed timbers of chengal. Each launch has a raked stem and transom type stern with a raised foredeck and helmsman's position forward.

Contract for Deisel Hopper Barges

Richard Dunston Ltd., Hessle, are to supply two diesel hopper barges to the Melbourne Harbour Trust Commissioners, Australia. With a deadweight of 1,150 tons, these vessels will have dimensions of 170-ft. B.P., 36-ft. moulded breadth and 17-ft moulded depth, and a hopper well capacity of 1,050 tons of spoil. Six vertical independent hydraulic rams control the twelve hopper doors which are arranged six a side, each ram handling one pair of doors. The propelling machinery will be capable of developing 1,098 b.h.p. at 275 r.p.m. and will give the vessel a service speed of about 10 knots.

Reconstruction of Dock Guide Stage

A contract in the region of £60,000 has been awarded to John Howard & Company Ltd., by the British Transport Commission (Southampton Docks) for the reconstruction of the Empress Dock Guide Stage.

This work includes the driving of approximately 300-ft. of sheet piling in the fairway to guide ships into the Empress Docks, and will replace the existing timber staging. The sheet piles will be tied back by tie rods, buried in concrete beams, carried on and braced by 81 angle driven cased piles.

The work is due to start immediately under the supervision of the Chief Docks Engineer (Southampton), and should be completed in eight months.

Manufacturers' Announcements—continued

Self-propelled Mobile Lift for Overhead Working

A self-propelled mobile lift, the "Mobiliftor" which can hoist a man to a height of 25 ft. in a few seconds has been introduced by the Thames Packaging Equipment Company, London, E.C.1.

From the working platform of this machine the operator exercises complete control by lever of climb and descent, or forward, backward and turning movements. The hoisting mechanism is an air compressor driven by a single-cylinder petrol engine. For movement from site to site, the Mobilifter is easily towed over long distances by another vehicle or, alternatively, can travel under its own power.

With low running and maintenance costs, this lift should have many applications in such work as day to day repairs, inspection and maintenance in shipyards and dry docks and in building and construction work.

(Left) Self-propelled mobile lift. (Above) Wheeled carriages for outriggers.

Wheeled Carriages for Outriggers

A new development to increase the scope and use of truck-mounted and self-propelled cranes has been introduced by Steels Engineering Products Ltd., Sunderland.

With practically all but the smallest type of self-propelled and truck cranes it is necessary to use telescopic outriggers and screw jacks to obtain maximum lifting capacity, a practice which completely restricts any chassis movement of the vehicle. This restriction must obviously limit the usefulness of a crane when lifting loads which demand the use of outriggers and stabilizing jacks.

The innovation introduced by Steels—the subject of patent application No. 16668/1959—is designed to permit forward and reverse movement of a crane with outriggers extended, and with a heavy or even maximum load on the hook. It consists of a rocking beam suspension bogie mounted on each of the four outriggers to replace the usual blocks or packing. Each bogie has two rollers fitted with solid rubber tyres. The only condition which is necessary when using this equipment is a reasonably level road.

This new accessory will make available to a mobile crane of up to 25 tons capacity, duties which would normally be possible only by the use of blocked stabilizers.

CLASSIFIED ADVERTISEMENTS

Rates 4s. per line (minimum 8s.); Box Number 2s. extra; Rate for single column inch is £2 per inch. Prepayment of classified advertisements is requested. Orders should be sent to Advertisement Department, "The Dock and Harbour Authority," 19, Harcourt Street, London, W.1. Telephone: PAD 0077.

APPOINTMENTS VACANT

PORT OF BRISTOL AUTHORITY

Vacancy exists in Engineer-in-Chief's Department, Avonmouth Docks for

AN ASSISTANT ENGINEER (MECHANICAL)

Salary Grade APT V.—£1,310—£1,480 p.a.

Candidates should have served an approved apprenticeship and have had design experience. They should be Corporate Members of a recognised Engineering Institution or eligible for Corporate Membership within two years.

Duties will include repair and maintenance of grain handling machinery, cranes, locomotives, pumps, etc. and preparation of specifications, estimates, etc. for new work.

Commencing salary within range quoted will depend upon experience. Post pensionable; medical examination and probationary period of six months.

Applicants must disclose whether they are related to a member or senior officer of Bristol Corporation. Canvassing disqualifies.

Applications stating age, qualifications, experience, etc. and enclosing, if possible, copies of recent testimonials, to Engineer-in-Chief, Port of Bristol Authority, Avonmouth Docks, Bristol, by 10 a.m., 31st December.

MERSEY DOCKS AND HARBOUR BOARD

ASSISTANT ENGINEER-IN-CHIEF

Applications are invited for appointment to the above post at an initial salary up to £3,000 per annum, depending on qualifications and experience. Candidates must be fully trained and qualified Civil Engineers with wide experience in the design and execution of port works and at present hold a senior position with a Port Authority or Contractor.

There is a prospect of early promotion to the post of Principal Assistant and candidates must therefore possess good executive and administrative ability as well as high technical qualifications.

After a satisfactory probationary period the person appointed would be subject to the Board's Conditions of Service.

Applications should be received by the undersigned not later than the 30th January, 1961 and be marked "Assistant Engineer-in-Chief."

A. S. MOUNTFIELD,
General Manager and Secretary.

Dock Office,
Liverpool, 3.

ENGINEERS with experience of hydraulics aspects of one of more of the following: harbour and coastal engineering, irrigation and river control, hydro-electric schemes. Research or experience in the use of hydraulic model techniques to provide design data, an advantage. One vacancy is for a senior engineer to take charge of a hydraulics engineering team. A.M.I.C.E. or equivalent qualification essential. Interesting, varied, theoretical and practical work with good salary and promotional prospects. Apply: GEORGE WIMPEY & CO., LIMITED, Springfield Road, Hayes, Middlesex.

FOR SALE

DOCKSIDE DERRICK CRANE for sale, Monotower 140-ft. high, 130-ft. Jib; 7 ton at 100-ft. radius, 5 ton at 127-ft. 6-in. radius. New unused. Electric 400/440-v. 3-ph. 50-c. Lying London. Box No. 240, "The Dock and Harbour Authority," 19 Harcourt Street, London, W.1.

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